PETRO-CANADA ®

Petro-Canada Products Research & Development Centre
Produits Petro-Canada le centre de recherche et de developpement

REPORT NO. SP87-023

PROCESSABILITY AND REACTIVITY OF HEAVY ENDS

Final Report

by

J. Chmielowiec

June, 1987

88-01194/

REPORT NO: SP87-023

PROCESSABILITY AND REACTIVITY OF HEAVY ENDS

Final Report

by

J. Chmielowiec

Work on this project was conducted under the auspices of
Canada Centre for Mineral and Energy Technology
Energy, Mines and Resources Canada

DSS FILE NUMBER	:	06SQ.23440-5-9090
DSS CONTRACT SERIAL NUMBER	:	OSQ85-000178
NRS SCIENTIFIC AUTHORITY	:	DR. S. COULOMBE

PETRO-CANADA PRODUCTS
RESEARCH AND DEVELOPMENT CENTRE
SHERIDAN PARK, ONTARIO

MICROMEDIA

91 pp

June, 1987

COMPANY CONFIDENTIAL
DO NOT DISCLOSE TO UNAUTHORIZED PERSONNEL

TABLE OF CONTENTS

		Page No.
1.	SUMMARY	1
2.	INTRODUCTION	2
	2.1 Objective	2
	2.2 Justification	2
	2.3 Background	2
3.	EXPERIMENTAL	5
	3.1 Samples	5
	3.2 Polar Concentrates	5
	3.3 Derivatization Agents	6
	3.4 Derivatization Experiments	6
	3.5 I.R. Analysis of Polar Concentrates and Derivatization Products	10
	3.6 Derivatization Experiments Using Gas Oil/ Residual Oil Blends	10
	3.7 I.R. Analysis of Blends and Derivatization Products	13
	3.8 Molecular Weight Distribution	13
	3.9 Microactivity Test (MAT)	13
	3.9.1 Determination of MAT operating conditions	14
	3.9.2 Determination of Catalytic Cracking Chracteristics of the Derivatization Products	15
4.	RESULTS AND DISCUSSION	16
	4.1 Derivatization Reactions	16
	4.2 FCC Microactivity Tests	18
	4.3 Conclusions and Recommendations	19
5.	ACKNOWLEDGEMENT	20
6.	REFERENCES	21
	TABLES	
	FIGURES	
	APPENDIX 1	

1. SUMMARY

FCC feed pretreatment concept based on the use of highly reactive derivatizing agents was experimentally tested. Polar components of Syncrude coker gas oil, deasphalted Athabasca bitumen and Lloydminster ATB were derivatized with four reactant types. The cat cracking yields of the silylated, acetylated, fluorinated and alkylated feeds were evaluated.

Compositional changes, mainly in stuctures of nitrogen and oxygen functionalities, were effected by derivatization and led to significant reduction in coke make and some increase in C_6+ gasoline yield.

The derivatization had the most effect on the Syncrude coker gas oil blend. The agents such as borontrifluoride butanol and acetic anhydride were found to be particularly active in modifying cat cracking behaviour of feeds containing heavy end components.

2. INTRODUCTION

2.1 Objective

The primary objective of this program was to obtain background information on the role of polar components in catalytic cracking of heavy ends.

A secondary objective was to test and improve in-house methods of characterization of polar functionalities in heavy ends.

2.2 Justification

Nitrogen species and asphaltenic components of heavy ends render catalytic cracking processes less efficient and less economical. Depending on their nature and concentrations, they can severely limit or poison the catalyst activity.

Selective alkylations, acylations, fluorinations and silylations are expected to extend insight into the types of polar components in residual oils and determine roles of those components in catalytic cracking of heavy ends. The derivatization reactions are intended to lead to defining a pretreatment type appropriate for incorporating heavy ends of various origin into fluid catalytic cracking (FCC) feedstocks.

2.3 Background

A wide variety of nonhydrocarbon constituents both heteroatom species and compounds with attached polar functional groups occur in heavy ends of conventional and nonconventional origin. Elemental analyses have revealed increased concentrations of nitrogen-, oxygen-, sulfur- and metal-containing species in residual oils. Higher concentrations of such components, in general, are associated with problems in processing of heavier feedstocks and their products. For instance, nonhydrocarbon species present in charge stocks to catalytic processes can severely limit or poison the activity of the catalyst. Additionally, objectionable characteristics are imparted to upgrading products due to the presence of species with polar functionalities.

Discrete compositional information on the polar constituents in heavy ends and characteristics of their reactivity may contribute

to more economic processing of these fractions. The structure and functionalities present in heavy ends and/or petroleum asphaltenes have been the subject of much research (1-3). The overall structure of these materials is thought to be a combination of polyaromatic, alicyclic and alkyl moieties. Atoms such as oxygen, nitrogen and sulfur make up the functionalities present, while metals, mainly nickel and vanadium, are also present.

The molecular characterization of the polar species is achieved using various analytical techniques. Foremost those mass spectrometry (4), infrared spectrometry (5-7), NMR (8) and potentiometry (9) are capable of providing discrete molecular insight. Nevertheless, an assessment of the polar functionalities in heavy ends is still a complex problem. These functionalities do not easily lend themselves to direct analysis by a single technique.

Derivatization techniques were used to advance compositional information about polar functional groups in asphaltenes (10,11) to explain separability of oil sand by the hot water process (12) and to improve heteroatom determination (13). There are process-related applications of derivatization reactions - alkylations, in particular. These include conversion of light olefins into gasoline (14), reductive alkylation reactions as a means of solubilizing various fossil fuel materials (15) and oxygen alkylation of phenol-containing hydrocarbonaceous streams (16).

A variety of reactions may be employed in the preparation of derivatives (17). Replacement of active hydrogen in polar groups (OH, COOH, SH and NH) is the most frequently employed and involves principally alkylation, silylation and acylation.

The principal reaction employed for alkylation is nucleophilic displacement as shown below:

$$\text{Sample - OH} \xrightarrow[\text{base}]{\text{R}'\text{-X}} \text{Sample - O-R}' + \text{HX}$$

The resulting products are ethers, esters, thioethers, thiolesters, N-alkylamines and N-alkylamides. The general reaction for silylation proceeds as follows:

$$\text{Sample - OH} + \text{R}_3\text{Si - X} \longrightarrow \text{Sample - O-SiR}_3 + \text{HX}$$

and trimethylsilyl derivatives are usually produced. Acyl derivatives are usually formed with acyl anhydride, acyl halide or activated acyl amide reagents.

The impact of feedstock quality on the operation of FCCU has been reviewed in several papers (18). The deleterious effects of nitrogen compounds on the performance of cracking catalysts has been known for many decades (19). Recent reports suggest that the extent of catalyst poisoning depends on the specific nitrogen compounds in the cat cracker feed (20-22). This study was undertaken to further understanding of how types of polar compounds (nitrogen functionality in particular) affect cat cracking yields.

3. EXPERIMENTAL

3.1 Samples

Four feedstocks were obtained from the operating departments of Petro-Canada. These were:

Atmospheric Tower Bottoms of Lloydminster Heavy Oil 360°C+ (LLOYD)

Athabasca Bitumen - deasphaltened oil topped at 220°C+ (ATH) The bitumen was deasphalted as in (23) and light end distilled off in the R&D Centre

Syncrude Heavy Coker Gas Oil (SYN)

Gas Oil product from hydrocracking Syncrude gas oil (HSYN)

The first three feedstocks were used to generate samples of polar concentrates and also in FCC tests. Selected characteristics of these feedstocks are shown in Table 1. HSYN, which contains nitrogen and sulfur at low concentrations and is light FCC feed, was used as a diluent to prepare 50/50 blends with three heavy materials. The addition of the diluent was necessary to allow injecting heavy feedstock onto the catalyst bed and reducing coke make.

3.2 Polar Concentrates

Polar constituents of three heavy feedstocks were preconcentrated prior to screening derivatization reactions. The liquid chromatographic method was as follows:

30 g samples were separated on two detachable gravitational flow glass chromatographic columns. The upper column (25 cm x 10 mm I.D.) was packed with clay absorbent (Florex AA-LVM, 250-600 m, Floridin Co.). The lower column (50 cm x 10 mm I.D.) was packed with equal amounts of silica (Silica Gel, 75-100 m, grade 923, Davison Chemical Div.) and alumina (Alumina F-20, 750-150 m, Alumina Co. of America). The silica and alumina packings were activated at 220°C for 24 hours and 400°C for 16 hours respectively. The clay was dried at 220°C for 16 hours and hydrated to 12% w/w H_2O.

The saturates were eluted with 70 mL hexane from the combined columns. The aromatics were eluted from the silica/alumina column with 75 mL diethyl ether followed

by 70 mL 80:20 diethyl ether/dry methanol to elute polar fraction. The effluent containing polars was left for 24 h in the fumehood to allow eluent vaporization and yield polar concentrate.

Based on the mass balancing eluates with whole sample, overall sample losses from 1 to 4 wt.% were observed.

3.3 Derivatization Agents

Information on these reagents is compiled in Tables 2A and 2B.

3.4 Derivatization Experiments

Four types of selective conversion of polar functional groups into less polar ones were tested. These were alkylation, acetylation, fluorination and silylation. Information on the reagents and procedures used to select the most active derivatization agents is shown in Tables 3 and 4. Table 5 summarizes conversions of OH and NH groups observed after treatments with the preselected reactants. The derivatization procedures applied were as follows:

Derivatization No. 1 - Pentafluorobenzylbromide

20 mL of aqueous solution of 0.1M t-Butylammonium hydrogen sulfate and 0.2M sodium hydroxide was combined with 100 mg of each of the polar concentrates in 2 mL of methylene chloride. 1.2 mL of reagent was added and stirred for 30 min. Methylene chloride was evaporated, the hydrocarbon phase was extracted with toluene and the toluene was removed from the product by evaporation under vacuum at 150°C.

Derivatization No. 2 - Trimethylchlorosilane

The polar concentrates (100 mg each) were combined with 2 mL of pyridine and 2 mL of TMCS. The solution was stirred at 70°C for 18 h. The reagent was removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 3 - N-Methyl-bis(trifluoroacetamide)

The three polar concentrates (100 mg each) were combined with 2 mL of pyridine and 2 mL of MBTFA. The mixture was stirred at 65°C for 1.5 h. The reagent was removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 4 - Trifluoracetyl Imidazole

3 mL of reagent were reacted with 150 mg of each of the 3 polar fractions at 90°C for 1.5 hours. At the end of the reaction time 20 mL of brine was added to each fraction. Toluene was then used as the extracting agent and then removed by evaporation at 150°C under vacuum.

Derivatization No. 5 - N-Trimethyl Silylimidazole

The three polar fractions (150 mg each) were combined with 0.35 mL of THF, 1 mL of acetonitrile and 3 mL of TSIM at 70°C for 1.5 hours. The reagents were removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 6 - Hexamethyldisilazane

1 mL of pyridine, 5 mL of toluene and 5 mL of HMDS were combined with 150 mg of each of the polar fractions. The mixtures were stirred for 18 hours at 50°C. The reagents were removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 7 - Boron Trifluoride - Methanol

0.5 mL of THF and 3 mL of reagent were added to 150 mg of each of the three polar fractions. The reaction was carried out for 12 minutes at 60°C. Saturated brine was then added to the mixture and the hydrocarbon phase extracted with toluene. Toluene was removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 8 - Acetic Anhydride

2 mL of pyridine and 4 mL of acetic anhydride were added to 150 mg of each of the 3 polar fractions. The reaction was carried out at room temperature under constant stirring for 3 days. The reagents were removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 9 - Methyl-8 (Dimethyl Formamide Dimethyl-acetyl in Pyridine)

Each of the three polar fractions (150 mg) were dissolved in THF (1 mL) and reacted with Methyl-8 (2 mL) at 60°C for 30 minutes. Water (5 mL) was added to the reaction product with shaking followed by a 5% aqueous ammonia solution (5 mL) with further shaking. The reacted polars were extracted with toluene and the toluene removed by evaporation at 150°C under vacuum.

Derivatization No. 10 - Hexamethyldisilazane

1 mL of pyridine, 5 mL of toluene and 5 mL of HMDS were combined with 150 mg of each of the polar fractions. The mixtures were stirred for 18 hours at 90°C. The reagents were removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 11 - Diazomethane

Batches of diazomethane in ether were prepared for treating the three blended heavy oils. To treat the polar fractions, 150 mg of samples dissolved in 2 mL of THF were reacted with 1 mmole (50 mg) of diazomethane in ether. The ether, excess diazomethane, and THF allowed to evaporate from the reaction product with occasional swirling.

The Aldrich Diazald Kit was used to prepare batches of diazomethane. 20 mL of ether was added through the dropping of 6 g of KOH and 10 mL of water maintained at 65°C in the distilling flask. The flask was stirred (Teflon stirrer) during the experiment. To prepare sufficient material to treat 7 g of blended heavy oil, 2 g of diazald dissolved in 20 mL of ether was added to the distilling flask, followed by another batch (approximately 20 mL) of ether until the ether distillate was colourless. The ethereal solution was collected in an ice bath. Further batches of diazomethane were prepared by simply adding more ether and diazald solution, observing the above precautions.

Derivatization No. 12 - Boron Trifluoride - Methanol

0.5 mL of pyridine and 3 mL of reagent were added to 150 mg of each of the three polar fractions. The reaction was

carried out for 12 minutes at 60°C. Saturated brine was then added to the mixture and the organic phase extracted with toluene. Toluene was removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 13 - Boron Trifluoride - Butanol (10% w/w)

The Syncrude polar fraction (150 mg) dissolved in THF (0.5 mL) was reacted with 3 mL of the reagent at 60°C for 12 minutes. Saturated brine (20 cc) was added to the reaction mixture and the polar fractions then extracted with toluene. Toluene was removed by evaporation.

Derivatization No. 14 - t-Butyldimethylsilylimidiazole

The Syncrude polar fraction (150 mg) dissolved in THF (0.5 mL) and acetonitrile (1 mL) was reacted with 3 mL of the reagent at 65°C for 2.5 hours. The reagents were removed from the product by evaporation at 150°C under vacuum.

Derivatization No. 15 - Diethylaminosulphur Trifluoride*

Each of the three polar fractions (150 mg) dissolved in methylene chloride (5 mL) and added to DAST (1.5 mL). The reaction mixture was stirred for 18 hours at room temperature. The excess reagent was destroyed by pouring the mixture into sodium bicarbonate solution (5%)*. The organic phase was separated and methylene chloride was removed from the product by evaporation.

*Caution is required, DAST reacts violently with water producing HF.

Derivatization No. 16 - Methyl-8 (Dimethyl Formamide Dimethylacetyl in Pyridine)

The Athabasca and Lloydminster polar fractions (150 mg) were dissolved in THF (1 cc) and reacted with Methyl-8 (2 cc) at 70°C for 90 minutes. Water (5 mL) was added to the reaction product with shaking followed by a 5% aqueous ammonia solution (5 mL) with further shaking. The reacted polars were extracted with toluene and the toluene removed by evaporation.

Derivatization No. 17 - Trifluoracetyl Imidazole

3 mL of reagent were reacted with 150 mg of each of the 3 polar fractions at 110°C for 1.5 hours. At the end of the reaction time, 20 mL of brine was added to each fraction. Toluene was then used as the extracting agent and then removed by evaporation.

Derivatization No. 18 - Deuterated Methyl-8

The procedure outlined in Derivatization No. 13 was used to react 150 mg of Syncrude polars with deuterated Methyl-8 in pyridine.

3.5 I.R. Analysis of Polar Concentrates and Derivatization Products

The infrared spectra of the three polar fractions and all derivatization products were recorded using a Perkin Elmer 283B Spectrophotometer. Weighed blends in methylene chloride (nominal concentration 30 g/L) were prepared in order to quantify changes in absorbances caused by the derivatization reactions. Adsorption at 3490 cm^{-1} and 3450 cm^{-1} were assigned to phenol and carbazole functional groups respectively. The amount of reaction of these functional groups with the various reagents was estimated by comparing the OH and NH adsorbances of the reaction products with that of the appropriate polar fractions.

No attempt was made to quantify the changes in the adsorbance patterns occurring in the 1500-1900 cm^{-1} region, caused by the various reactions.

3.6 Derivatization Experiments Using Gas/Oil Residuum Blends

Samples of the Athabasca, Lloydminster and Syncrude heavy coker gas oils were blended with hydrocracked Syncrude gas oil. For convenience these samples and their derivatization products will be referred to as the:

Athabasca Blend	ATH B
Lloydminster Blend	LLOYD B
Syncrude Blend	SYN B
Derivatized ATH B	ATH DB
Derivatized LLOYD B	LLOYD DB
Derivatized SYN B	SYN DB

The derivatization experiments were carried out by reacting 7-10 g of the blend with an excess of the appropriate reagent. The reaction products were analyzed by I.R. to determine the success of the derivatization reaction (Table 6). Then the derivatization products were cracked in the microreactor.

Blend Derivatization No. 1 - Diazomethane

Batches of diazomethane in ether were prepared for treating the three blends and the three polar fractions. To treat the blends, an ethereal solution containing 7 mmoles (0.3 g) of diazomethane was added to 7 g of oil dissolved in 10 cc of THF. The ether, excess diazomethane, and THF were allowed to evaporate from the reaction product with occasional swirling. Bubbling was observed with the Syncrude bitumen/Syncrude gas oil blend.

The Aldrich Diazald Kit was used to prepare batches of diazomethane. 20 mL of ether was added through the dropping funnel to a mixture of 35 mL of 2-(2-ethoxyethoxy) ethanol, 6 g of KOH and 10 mL of water maintained at 65°C in the distilling flask. The flask was stirred (Teflon stirrer) during the experiment. To prepare sufficient material to treat 7 g of blended heavy oil, 2 g of diazald dissolved in 20 mL of ether was added to the distilling flask, followed by another batch (approximately 20 mL) of ether until the ether distillate was colourless. The ethereal solution was collected in an ice bath. Further batches of diazomethane were prepared by simply adding more ether and diazald solution, observing the above precautions.

Blend Derivatization No. 2 - Boron Trifluoride - Methanol

15 mL of pyridine and 30 mL of reagent were added to 10 g of each of the three blends. The reaction was carried out for 12 minutes at 60°C. Saturated brine was then added to the mixture and the hydrocarbon phase extracted with toluene. Toluene was removed from the product by evaporation at 150°C under vacuum.

Blend Derivatization No. 3 - Pentafluorobenzyl Bromine

10 g of each of the three blends dissolved in 150 mL of methylene chloride was added to 200 mL of an aqueous solution which was 0.2M in tetrabutylammonium hydrogen sulphate and 0.2M in sodium hydroxide. 6 mL of PFB bromide was added and the reaction mixture was stirred at room temperature for 30 minutes. The methylene chloride was evaporated, the hydrocarbon phase was extracted with toluene and the toluene was removed from the product by evaporation under vacuum at 150°C.

Blend Derivatization No. 4 - Hexamethyldisilazane

125 mL of pyridine, 200 mL of toluene and 20 mL of HMDS were combined with 10 g of each of the blends. The mixtures were stirred for 18 hours at 90°C. The reagents were removed from the products by evaporation at 150°C under vacuum.

Blend Derivatization No. 5 - Acetic Anhydride

50 mL of pyridine and 50 mL of acetic anhydride were added to 10 g of each of the 3 blends. The reaction was carried out at room temperature with constant stirring for 3 days. The reaction mixture was slowly added to 5% sodium bicarbonate solution and the resulting hydrocarbon phase extracted with toluene. The toluene extract was washed with water and the toluene was removed by evaporation under vacuum at 150°C.

Blend Derivatization No. 6 - Diethylaminosulphur Trifluoride

Each of the blends (10 g) dissolved in methylene chloride (200 mL) was cooled to -78°C prior to adding DAST (5 mL). The reaction mixture was allowed to warm to room temperature and stirred for eighteen hours. The excess reagent was destroyed* by slowly adding a 5% solution of sodium bicarbonate to the stirred reaction mix. Stirring was continued overnight. The organic phase was separated and the methylene chloride evaporated from the product.

Blend Derivatization No. 7 - BF3-Butanol (10% w/w)

The blend (10 g) dissolved in THF (150 mL) was reacted with 15 mL of the reagent at 65°C for 4.5 hours. Saturated brine (600 cc) was added to the reaction mixture and the hydrocarbon phase was extracted with toluene which was subsequently evaporated at 150°C under vacuum.

3.7 I.R. Analysis of Blends and Derivatization Products

The infrared spectra of the three blends and twenty derivatization products were recorded using a Perkin Elmer 283B Spectrophotometer. Weighed blends in methylene chloride (nominal concentration 150 g/L) were prepared in order to quantify changes in absorbances caused by the derivatization reactions. Adsorption at 3580 cm^{-1} and 3450 cm^{-1} were assigned to phenol and carbazole functional groups respectively. The amount of reaction of these functional groups with the various reagents was estimated by comparing the OH and NH absorbances of the reaction products with that of the appropriate polar fractions. Apparent conversion for the phenol group ranged from 12-59% and for the carbazole group from 1-48%. These data are summarized in Table 6.

No attempt was made to quantify the changes in the absorbance patterns occurring in the 1500-1900 cm^{-1} region, caused by the various reactions.

3.8 Molecular Weight (MW) Distribution

Gel permeation chromatography profiles of heavy ends, polar concentrates and selected derivatized products were recorded. The chromatographic system consisted of 500 Å μ-Styragel column and tetrahydrofuran. The eluent was pumped at 1 mL/min and eluates UV monitored at 285 nm.

3.9 Microactivity Test (MAT)

The laboratory sized MAT unit designed to simulate the performance of a cracker feed in a full sized catalytic cracking unit was used. Microactivity tests were carried out to correlate the derivatization of polar groups with feed processability.

The procedure employed was based on ASTM D3907-80 which is a standard method evaluating FCCU catalyst activity. A schematic diagram of the experimental apparatus is shown in Figure 1. A MAT reactor was a 40 cm long x 1.2 cm O.D. tabular reactor packed with known amount of catalyst DA-440 from Davidson, Baltimore. The feedstocks were injected onto the catalyst bed in amounts of approximately 1 mL at equilibrium temperature. The products: gases, liquids and coke on spent catalyst were determined for calculating a complete product yield. The derived data were fed to a reduction program to calculate the conversion and yield structure.

This data is all reported on a mass % basis which is atypical with most of the data reported in the literature, particularly that from commercial operations which is reported in liquid volume %. Due to the very small samples of materials collected and the fact that they are not fractionated into products, densities cannot be measured and accurate volumetric yields reported. However, the data can be converted to such yields if one is willing to assume average specific gravities for various materials. This should be done with caution.

The product yields are reported as a mass % of the feed and were calculated with the following expression:

$$\text{yield ith product} = (\text{weight ith product}/\text{weight feed}) \times 100$$

3.9.1 Determination of MAT Operating Conditions

A number of preliminary MAT runs were carried out to define suitable operating conditions. One series of MAT runs carried out at

Reactor Temperature	510
C/O	6/1
WHSV	10 hr^{-1}

is reported in Appendix 1. Due to the observed overcracking, microactivity tests were continued at lower temperature and catalyst to oil ratio.

3.9.2 Determination of Catalytic Cracking Characteristics of the Derivatization Products

The three blends and eighteen of the twenty derivatization products were cracked using the microreactor. (The products obtained from reacting both the Athabasca and Lloydminster blends with DAST were solids at 60°C and thus could not be injected into the microreactor.) For all of the runs the reactor temperature was 490°C and the C/O nominally 2/1. The WHSV was maintained at 12 hr^{-1} by injecting oil at the rate of 0.42 g/min into 2.1 g of catalyst.

The nitrogen purge was 20 cc/min for 15 minutes starting when oil was injected.

Gas volumes were determined using a volumeter, and the gas composition from H_2 up to and including C_6+ component, was determined by gas chromatography. The proportions of gasoline, LCO and DO in the reactor effluent liquid were determined by GCD. THe GCD methods was modified to allow the determination of C_5 and any lighter hydrocarbons in the liquid. The carbon on catalyst was determined as CO_2.

The material balance obtained ranged from 88.2-100.2%. Past work with conventional gas oil indicate material balances of 97-102%. The poorer material balance for the heavy feedstock was attributed to the coking on the reactor internals and any discrepancy in the material balance was attributed to the coke yield. Although this differs from the normal practice of assigning material loss to the gas yield, it is in our view a more realistic approach. Even with the injector needle resting on the catalyst bed there was still at times significant "coke" formation on the reactor internals. Some of the derivatization reactions increased the viscosity and coking propensity of the blends and it was difficult at times to inject the required amount of feedstock into the reactor before plugging off the needle with coke. The products were mass balanced with injected samples adding three components. These were:

gas wt = gas volume x molecular mass;
liquid wt; and
coke wt = carbon on catalyst x 1.1 x C/O.

Coke in the reactor was equal to 100% minus mass balance.

The reported volume percentages of the cracked material were based on an assumed feed density of 1 g/mL and hence may not be representative of the true yield volumes.

RESULTS AND DISCUSSION

4.1 Derivatization Reactions

The preselection of reactants for this study was made solely on the basis of expected reactivities and selectivities (Table 2B). The preliminary derivatization experiments were carried out to identify the most reactive derivatization agents and determine effect of the reaction conditions on the derivatization yields (see Tables 3 and 4). The balance of the derivatization experiments is summarized in Table 5.

The conversion of OH- and NH- functionalities were assessed using infrared spectroscopy. Decreasing absorbances at 3590 and 3460 cm^{-1} were assumed to characterize reactivities of the agents used and reflect changes in contents of OH (phenolic) and NH (pyrrolic) functional groups, respectively. However, the diminished absorbances were not expected to characterize completely an extent of the derivatization of other polar groups such as COOH functionalities and NH (imino) groups for instance. Most of the derivatizations caused changes in 1600-1900 cm^{-1} spectrum range, but interpretation of them was beyond the time frame of this project.

Attempts to use high resolutions mass spectrometry to monitor structural changes of polar compounds were not successful due to the low volatility of the polar samples. Both the polar concentrates and their derivatives hardly vaporized when introduced into the ion source.

Gel permeation chromatographic profiles permitted to detect differences in molecular weight among polar concentrates. Also changes in molecular weight as result of the derivatization were observed. Figure 2 shows that polars derived from Syncrude coker gas oil comprised of smaller molecules than those from Lloydminster ATB and deasphalted Athabasca bitumen 270°C+. Typical differences in molecular weight among heavy end sample, polar concentrate and its derivative can be seen in Figure 3. Overall observation with respect to molecular weight distribution was that molecular weight increased in order of heavy end sample, polar concentrate and derivatized concentrate.

Based on the derivatization results, seven reactants representing four types of the derivatization reactions and promising high derivatization yields were chosen for feed pretreatment experiments to follow. The following reactants were used to derivatize blends of each heavy material with HSYN:

	Rationale to use reactant for feed derivatization
1. Diazomethane	Significant increase in MW of the concentrate
2. Boron trifluoride methanol in pyridine	High conversion of OH and NH groups.
3. Pentafluorobenzylbromide	High conversion of OH and NH groups
4. Hexamethyldisilizane	Best silylating agent
5. Acetic anhydride	High conversion of OH and NH groups
6. Diethylaminosulfurtrifluoride	High conversion of OH and NH groups.
7. Boron trifluoride butanol	Increase in MW of the concentrate in concert with conversion of OH and NH groups.

Although several reactants gave high derivatization yields with polar concentrates, considerably smaller yields were obtained for the feeds - perhaps because of the matrix effect. The assessed conversion of OH and NH components in the derivatized feeds are shown in Table 6.

4.2 FCC Microactivity Tests

The fluid catalytic cracking mircroactivity tests allow to determine conversion and structure of product yields. Here, the MATs were used to detect changes in feed processability which might result from the derivatization of polar components.

Preliminary MATs carried out at catalyst to oil ratio (C/O) of 6/1 at 510°C showed significant feed overcracking and high coke makes. Reducing the cracking temperature to 490°C and the C/O to 2/1 significantly reduced the coke make. Therefore, the latter temperature and C/O were decided to be used for comparing MAT cracking yields of derivatized feeds with those of the reference blends. Raw data obtained from MAT runs and information on those runs are reported in Appendix 1. Tables 7-9 summarize cracking behaviour of the studied samples.

The MAT product yields for derivatized blends show that the derivatization, i.e. conversion of polar groups into less polar functionalities likely such as ethers, esters, fluorides and other alkyl-containing groups, decreases considerably coke lay-down. For most of the derivatized blends the reduction of coke make is accompanied by either small increases in yield of C_6+ gasoline or no change at all with exception of the butylated SYN-DB. Changes in FCC conversion were also minor or within experimental error of the test. The table below shows how the conversion, C_6+ gasoline yield and coke make compare with those of untreated blends.

Derivatization	Conversion			C_6+ Gasoline			Coke		
	ATH	LLOYD	SYN	ATH	LLOYD	SYN	ATH	LLOYD	SYN
1	nc	s↓	nc	nc	s↓	s↑	s↓	s↑	m↓
2	nc	nc	s↑	s↑	s↑	nc	l↓	s↓	s↑
3	nc	nc	s↑	s↑	s↑	s↑	s↓	m↓	s↓
4	nc	nc	s↓	nc	nc	s↓	nc	m↑	s↑
5	nc	s↓	m↓	s↑	nc	s↑	l↓	s↓	ll↓
6	-	-	s↑	-	-	s↑	-	-	ll↓
7	nc	-	m↑	s↑	-	l↑	l↓	-	ll↓

nc - no change s - small m - medium l - large
ll - very large ↑ - increase ↓ - decrease

From the above table it can be seen that derivatization has the most effect on the Syncrude coker gas oil blend. Large decreases in coke are also effected with Athabasca bitumen blend but not with Lloydminster ATB blend. ATBs, in general, contain high levels of additive coke which may not be effected by derivatization.

4.3 Conclusions and Recommendations

Pretreatment of heavy ends such as alkylations and acetylations prior to fluid catalytic cracking are beneficial for improving processability of feedstocks which incorporate residual fractions. The derivatization of hydroxyl and pyrrolic groups in concert with probable modifications of other proton donating groups are responsible for changes in feedstock cracking patterns. Specifically, significant reduction in coke make and some increase in C_6+ gasoline yield result from those structural changes.

Future work should concentrate on:

- assessing feasibility of FCC feed pretreatments with less expensive and readily available reactants;
- studying effect of matrix on the derivatization yields;
- obtaining larger and consistent data base to derive more specific relationships between types of polar components and changed cracking behaviour;
- better spectroscopic characterization of the derivatization products.

An overall objective of the future work should be maximizing both reduction of coke make and increase in gasoline yield, while advancing practicality of the derivatizations.

5. ACKNOWLEDGMENT

The author wishes to thank Dr. I.P. Fisher for helpful discussions.

6. REFERENCES

1. T.F. Yen, Energy Sources 1 (1974) 447

2. M.M. Boduszynski, J.F. McKay and D.R. Latham, "Asphaltenes, Where Are You?" Asphalt Paving Technology 1980, pp 123-143

3. J.G. Speight, Plenary Lecture on the Structure of Resids, 34th Canadian Chem. Eng. Conf. Quebec City, October, 1984

4. A.W. Peters and J.G. Bendoraitis, Anal. Chem. 48 (1976) 968

5. H. Sawatzky, S.M. Ahmed, A.E. George, G.T. Smiley, CANMET Report 77-10

6. J.F. McKay, J.H. Weber, D.R. Latham, Anal. Chem. 48 (1976) 891

7. S.E. Moschopedis and J.G. Speight, ACS Preprints, Div. Fuel Chem. 21 (1976) 198

8. L. Petrakis, D.T. Allen, G.R. Gavalas and B.C. Gates, Anal. Chem. 65 (1983) 1557

9. P.K. Dutta and R.J. Holland, Fuel 63 (1984) 197

10. S.E. Moschopedis and J.G. Speight, Fuel 55 (1976) 334

11. K.A. Gould, Fuel 58 (1979) 550

12. O.P. Strausz and D.S. Montgomery, AOSTRA/University Reports for Industry, Agreement No. 174

13. J.M. Dereppe and B. Parbhoo, Anal. Chem. 58 (1986) 2641

14. L.E. Chapin, G.C. Liolios and T.M. Robertson, Hydrocarbon Processing, Sept. 1985, p 67

15. L.M. Stock in 'Coal Science', Vol. 1 Academic Press, 1982 pp 161-282

16. R.H. Schlosberg, US Patent 4,326,949

17. D.R. Knapp, "Handbook of Analytical Derivatization Reactions" John Wiley & Sons 1979

18. R.E. Ritter et al., OGJ, July 6, 1981, p 103

19. G.A. Mills et al., JACS 72 (1950) 1554

20. G.M. Fu and A.M. Schaffer, ACS Preprints, Div. of Petr. Chem. Vol. 28(4) 1983, p 876

21. A. Corma, V. Fornes, J.B. Monton and A.V. Orchilles, ACS Preprints, Div. of Petr. Chem. 31 (1), 1986, p 184

22. J. Scherzer and D.P. McArthur, OGJ, Oct. 27, 1986, p 76

23. A.E. George, G.T. Smiley and H. Sawatzky in 'Oil Sand and Oil Shale Chemistry' Ed. O.B. Strausz and E.M. Lown Verlag Chemie New York 1978, p. 55

TABLE 1

CHARACTERISTICS OF FEEDSTOCKS STUDIED

	LLOYD	ATH	SYN	HSYN
Density @ 15°C	--	--	0.9654	0.8778
Total S, % w/w	6.36	4.86	5.24	--
Total N, ppm	5301	4709	2836	--
V content, ppm	137	202	--	--
Ni content, ppm	64.4	79	--	--
Gas Chromatographic Distillation, °C				
IBP	--	--	260	276
10%	--	--	327	345
20%	--	--	354	365
30%	--	--	374	378
40%	--	--	393	388
50%	--	--	411	398
60%	--	--	430	409
70%	--	--	499	421
80%	--	--	472	438
90%	--	--	502	465
FBP	--	--	602	541
Polars by Liquid Chromatography, wt%	17.4	20.2	6.7	--

TABLE 2A

STRUCTURES OR CHEMICAL FORMULAS OF REAGENTS USED

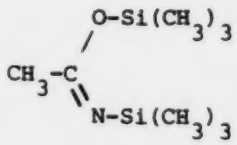
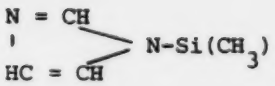
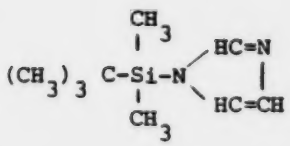
$(C_2H_5)_2\ N\text{-}SF_3$	Diethylaminosulphur trifluoride (DAST)
	N,O-bis(Trimethylsilyl)-acetamide (BSA)
	Trimethylsilylimidiazole (TSIM)
$(CH_3)_3Si\text{-}NH\text{-}Si(CH_3)_3$	Hexamethyldisilazane (HMDS)
$(CH_3)_3\ SiCl$	Trimethylchlorosilane (TMCS)
	t-Butyldimethylsilylimidiazole (TBDSI)

TABLE 2A Continued

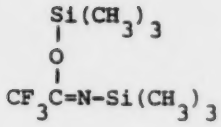
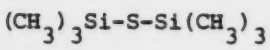
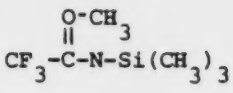
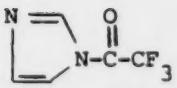
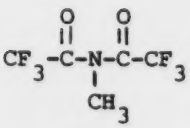
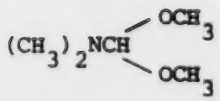
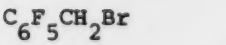
	N,O-bis(Trimethylsilyl)trifluoro acetamide (BSTFA)
	Hexamethylsildithiane (HMSDT)
	N-Methyl-N-trimethylsilyl trifluoroacetamide (MSTFA)
	Trifluoroacetylimidiazole (TFAI)
	N-Methyl-bis(trifluoroacetamide) (MBTFA)
	Dimethylformamide-Dimethylacetal (METHYL-8)
	Pentafluorobenzylbromide (PFBBr)

TABLE 2A Continued

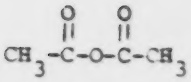
	Acetic Anhydride (AA)
CH_2N_2	Diazomethane (DM)
BF_3 . MeOH	Borontrifluoride methanol (BTM)
BF_3 ° BtOH	Borontrifluoride butanol (BTB)

TABLE 2B

REAGENTS - REACTIVITIES EXPECTED

Pretreatment	Reagent	Reactivity/Selectivity
Acylation	TFAI	will aceylate hydroxyls, primary and secondary amines as well as pyrrolic groups
	MMBTFA	trifluoroacetylates primary and secondary amines, hydroxyl- and thio-groups. It can also be used for selective acylation of amines in the presence of hydroxyl and carbonyl functionalities.
	AA	nonselective acetylation of hydroxyls
Alkylation	METHYL-8	reacts with primary amines and carboxylic groups. Selective alkylation were achieved in the ~resence of hydroxyl groups.
	PFBBr	alkylates, carboxylic acids and phenols. "Fingerprints" asphalts.
	BTM or BTB	esterification
	DM	nonselective methylation
Fluorination	DAST	fluorinates alcohols, ketones and aldehydes
Silylation	BSA	forms TMS derivatives with alcohols, phenols, carboxylic acids and amines
	TSIM	reacts quickly with hydroxyls and carboxylic acids but not with amines
	HMDS	nonselective silylation
	TMCS	nonselective silylation
	TBDSI	as TSIM
	BSTFA	powerful trimethylsilyl donor, more volatile than others
	HMSDT	nonselective silylation
	MSTFA	strongest in donor strength

TABLE 3

DERIVATIZATION OF SYNCRUDE POLARS - REAGENT SCREENING REACTIONS

Reagent	Procedure	Conversion of Functional Groups by IR Spectroscopy, % NH (3460 cm^{-1})	OH (3590 cm^{-1})	C=O (1900-1600 cm^{-1})
Acetylation				
TFAI	1) S 1.5 h in reagent at 90°C Sat. NaCl added, product extracted with toluene.	27	38	0
	2) S 1.5 h in pyridine at 70°C, product recovered as above.	X	0	X
MBTFA	1) S in THF at 70°C	X	34	X
	2) S in pyridine at 70°C	0	25	X
AA	1) S 3 days in pyridine at R. T.	13	77	E
	2) S 24 h in pyridine at 70°C			
Alkylation				
METHYL-8	1) S*10 min in THF at 70°C	none	25	X**
	2) S 1.5 h in pyridine at 70°C	X	10	X
BTM	1) S 12 min in THF at 60°C	58	43	30
	2) S 4.5 h in THF at 65°C, sat. NaCl added, product extracted with toluene	52	66	E***
BTB	as above	29	24	E
DM	left overnight in ether until the reagent evaporated	47	48	E
DM+	as above	35	16	E

* S - stirring at specified temperature
** X - inconclusive results
*** E - band(s) assigned to ester
\+ reaction performed on Athabasca polars

TABLE 4

SILYLATIONS OF SYNCRUDE POLARS - REAGENT SCREENING REACTIONS

Reagent	Procedure	Conversion of Functional Groups by IR Spectroscopy, %		
		NH (3460 cm^{-1})	OH (3590 cm^{-1})	C=O (1900-1600 cm^{-1})
MSTFA	S 18 h in pyridine at 50°C	X	100	0
HMDS	S 18 h in pyridine at 50°C	7	100	0
TMCS	S 18 h in pyridine at 50°C	61	100	X
BSTFA	S 18 h in pyridine at 50°C	X	100	X
HMSDT	S 18 h in pyridine at 50°C	X	high	0
BSA	1) S 2 h in THF at 65°C	27	48	X
	2) S 2 h in pyridine at 70°C	0	25	X
	3) S 3.5 h in THF at 65°C	22	19	X
TSIM	1) S 1.5 h in THF at 70°C	X	100	complete
	2) S 3.5 h in THF at 65°C	X	58	X
TBDSI	S 2.5 h in THF/Acetonitrile at 65°C	76	50	X

TABLE 5

DERIVATIZATION OF POLAR COMPONENTS

Derivatization Reaction	Polar Concentrate	Reactant	% Conversion OH ($3590\ cm^{-1}$)	% Conversion NH ($3460\ cm^{11}$)
	SYN		42	100
1	ATH	PFBBr	X	100
	LLOYD		X	100
	SYN		--	--
2	ATH	TMCS	X	X
	LLOYD		X	39
	SYN		38	X
3	ATH	MBTFA	X	X
	LLOYD		X	17
	SYN		31	31
4	ATH	TFDAI	35	30
	LLOYD		30	52
	SYN		58	18
5	ATH	TSIM	9	X
	LLOYD		42	X
	SYN		42	9
6	ATH	HMDS	38	30
	LLOYD		32	24
	SYN		54	36
7	ATH	BTM	30	32
	LLOYD		35	36
	SYN		89	14
8	ATH	AA	90	40
	LLOYD		75	20

TABLE 5 Continued

Derivatization Reaction	Polar Concentrate	Reactant	% Conversion OH (3590 cm^{-1})	% Conversion NH (3460 cm^{11})
	SYN		52	11
9	ATH	METHYL-8	21	15
	LLOYD		32	30
	SYN		39	8
10	ATH	HMDS	20	23
	LLOYD		17	3
	SYN		26	8
11	ATH	DM	23	7
	LLOYD		42	25
	SYN		80	X
12	ATH	BTM	61	41
	LLOYD		58	48
13	SYN	BTB	25	X
14	SYN	TBDSI	85	66
	SYN		83	100
15	ATH	DAST	80	100
	LLOYD		42	100
16	ATH	METHYL-8	69	65
	LLOYD		55	61
	SYN		88	78
17	ATH	TFAI	66	78
	LLOYD		68	62
18	SYN	Deuterated Methyl-8	98	71

TABLE 6

ASSESSMENT OF CONVERSION OF OH AND NH SPECIES IN DERIVATIZED CRACKING FEEDS

Derivatization Reaction	Derivatized Blend	Reactant	% Conversion OH (3590 cm^{-1})	% Conversion NH (3460 cm^{11})
1	SYN DB-1	DM	X	14
	ATH DB-1		X	13
	LLOYD DB-1		14	5
2	SYN DB-2	BTM	14	5
	ATH DB-2		13	X
	LLOYD DB-2		12	7
3	SYN DB-3	PFBBr	49	56
	ATH DB-3		56	37
	LLOYD DB-3		37	48
4	SYN DB-4	HMDS	14	11
	ATH DB-4		45	1
	LLOYD DB-4		54	0
5	SYN DB-5	AA	58	31
	ATH DB-5		51	25
	LLOYD DB-5		59	32
6	SYN DB-6	DAST	26	47
	ATH DB-6		X	43
	LLOYD DB-6		X	37
7	SYN DB-7	BTB	X	41
	ATH DB-7		X	28

TABLE 7

MAT PRODUCT YIELDS FOR SYNCRUDE BLEND AND ITS DERIVATIZED PRODUCTS

Feed	Blend	DB-1	DB-2	DB-3	DB-4	DB-5	DB-6	DB-7
Mass Balance, wt%	94.71	97.21	92.04	95.55	94.42	98.82	100.29	99.65
Temperature, °C	490	490	490	490	490	490	490	490
C/O, g/g	2.091	2.143	2.130	2.120	2.213	2.304	2.018	2.287
Product Yields, wt%								
H_2	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02
CH_4	0.21	0.25	0.22	0.22	0.40	0.26	0.29	0.23
ΣC_2	0.64	0.70	0.63	0.61	0.62	0.71	0.69	0.75
ΣC_3	2.68	2.92	2.68	2.60	2.54	2.80	2.65	3.26
ΣC_4	5.07	5.44	5.12	5.18	4.77	5.25	4.91	7.56
ΣC_5	4.23	4.75	4.54	4.50	4.16	4.63	4.40	5.32
C_6^+ gasoline	31.76	34.10	33.08	35.47	29.53	34.03	33.65	39.78
LCO	22.12	22.47	19.73	21.56	20.69	23.62	22.94	24.11
DO	20.56	19.81	19.80	19.49	24.08	22.66	21.69	13.84
Coke	11.54	8.33	12.99	9.09	12.08	4.78	6.97	3.79
Conversion	57.32	57.72	60.47	58.95	55.22	53.71	55.37	62.05
Coke/Conversion	0.201	0.145	0.215	0.154	0.218	0.088	0.130	0.061
C_6^+ gasoline/conversion	0.554	0.595	0.547	0.602	0.534	0.633	0.608	0.641
Coke/(C/O)	5.52	3.89	6.10	4.29	5.46	2.07	3.43	1.66

TABLE 8

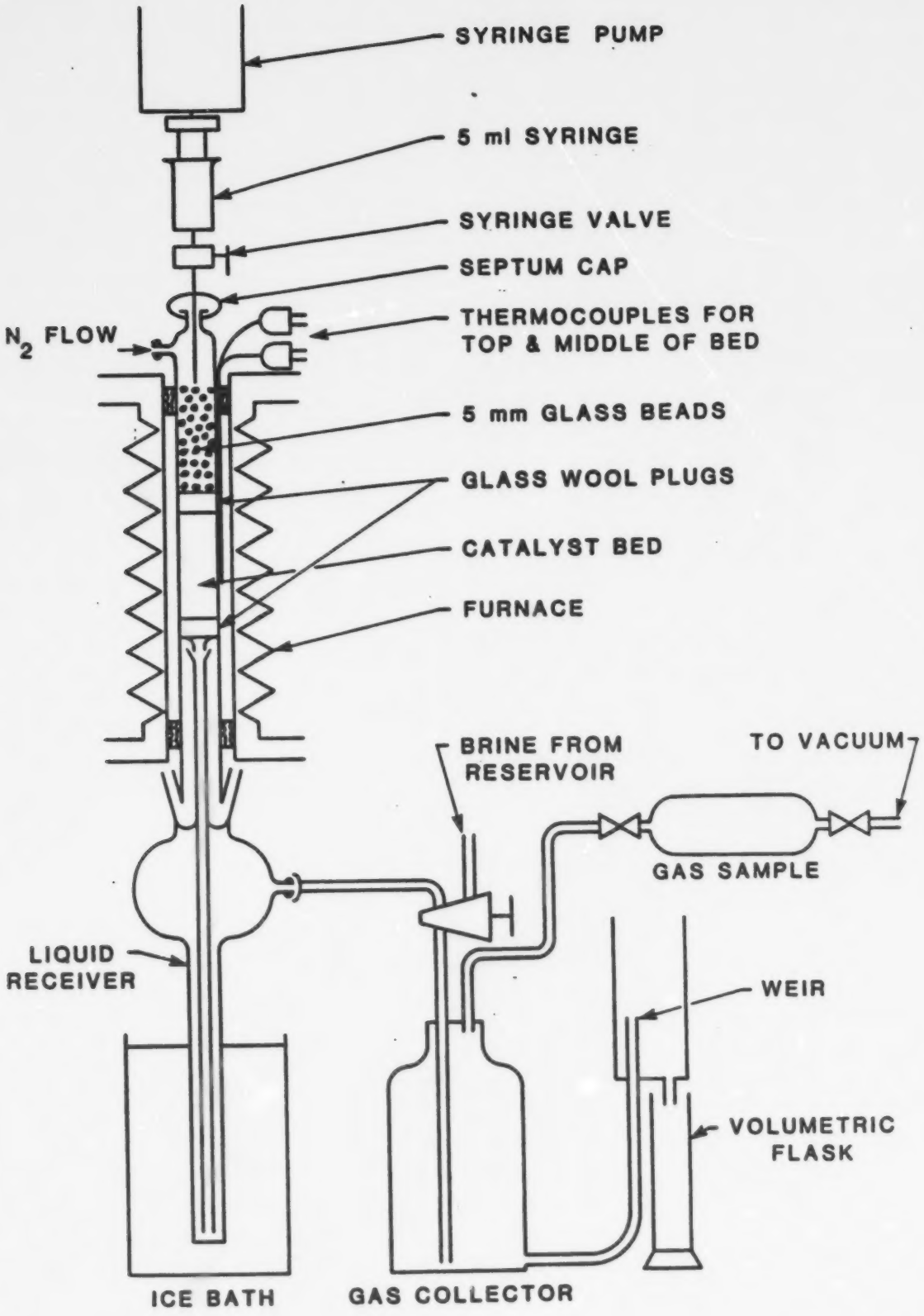
MAT PRODUCT YIELDS FOR LLOYDMINSTER BLEND AND ITS DERIVATIZED PRODUCTS

Feed	Blend	DB-1	DB-2	DB-3	DB-4	DB-5
Mass Balance, wt%	93.3	93.51	95.57	94.75	92.04	97.03
Temperature, °C	490	490	490	490	490	490
C/O, g/g	2.263	2.233	2.457	2.260	2.197	2.196
Product Yields, wt%						
H_2	0.03	0.02	0.03	0.02	0.02	0.03
CH_4	0.49	0.45	0.50	0.48	0.58	0.48
ΣC_2	1.05	0.95	1.08	1.02	0.95	0.98
ΣC_3	4.29	4.04	4.44	4.37	3.94	3.86
ΣC_4	8.60	8.09	8.78	9.16	6.84	7.63
ΣC_5	7.73	6.03	7.64	7.19	6.74	6.51
C_6+ gasoline	42.64	42.13	43.95	45.25	41.94	43.76
LCO	14.53	15.37	14.41	14.41	14.78	17.36
DO	5.35	5.92	5.28	5.45	5.40	6.51
Coke	13.61	14.37	12.06	10.90	16.15	11.25
Conversion	80.12	78.72	80.31	79.89	78.86	76.12
Coke/Conversion	0.170	0.182	0.150	0.136	0.205	0.148
C_6+ gasoline/conversion	0.532	0.535	0.547	0.566	0.531	0.575
Coke/(C/O)	6.01	6.43	4.91	4.82	7.35	5.12

TABLE 9

MAT PRODUCT YIELDS FOR ATHABASCA BITUMEN BLEND AND ITS DERIVATIZED PRODUCTS

Feed	Blend	DB-1	DB-2	DB-3	DB-4	DB-5	DB-7
Mass Balance, wt%	90.49	92.09	92.80	88.54	91.08	96.03	97.26
Temperature, °C	490	490	490	490	490	490	490
C/O, g/g	2.222	2.104	2.254	2.265	2.174	2.33	2.475
Product Yields, wt%							
H_2	0.03	0.02	0.03	0.02	0.02	0.03	0.03
CH_4	0.38	0.41	0.53	0.43	0.56	0.48	0.45
ΣC_2	0.88	0.83	1.13	0.93	0.91	1.06	1.03
ΣC_3	3.66	3.51	4.30	3.76	3.73	4.17	4.15
ΣC_4	7.30	6.97	8.23	7.49	7.40	8.18	9.72
ΣC_5	6.36	6.40	9.18	6.62	6.46	7.07	6.43
C_6^+ gasoline	40.11	40.48	43.31	41.08	40.47	43.60	43.8
LCO	15.70	16.54	15.19	15.36	15.35	16.60	16.16
DO	6.10	6.49	6.01	5.70	5.75	5.84	5.56
Coke	17.83	16.85	12.13	17.48	17.69	11.16	11.67
Conversion	78.20	76.97	78.80	78.94	77.92	77.56	78.28
Coke/Conversion	0.228	0.218	0.154	0.221	0.227	0.144	0.149
C_6^+ gasoline/conversion	0.513	0.526	0.550	0.520	0.519	0.562	0.551
Coke/(C/O)	8.03	8.01	5.38	7.71	8.13	4.79	4.71



A SCHEMATIC DIAGRAM OF THE MICROACTIVITY TEST APPARATUS

FIGURE 1

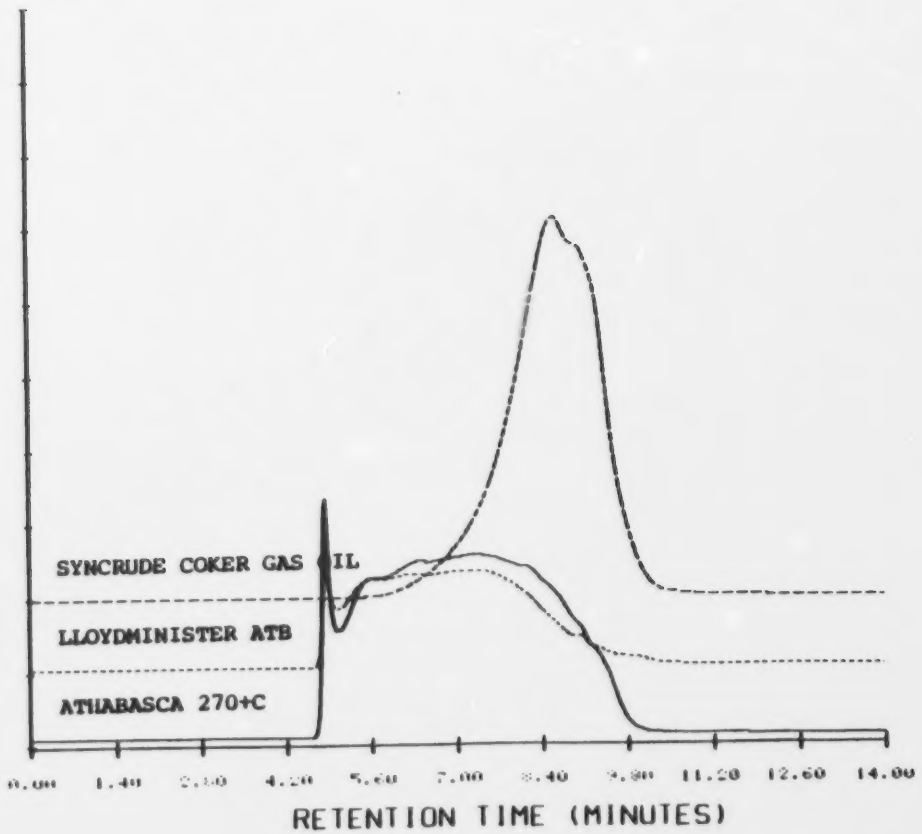


FIGURE 2

GEL PERMEATION CHROMATOGRAPHY COMPARISON OF FEEDS STUDIED

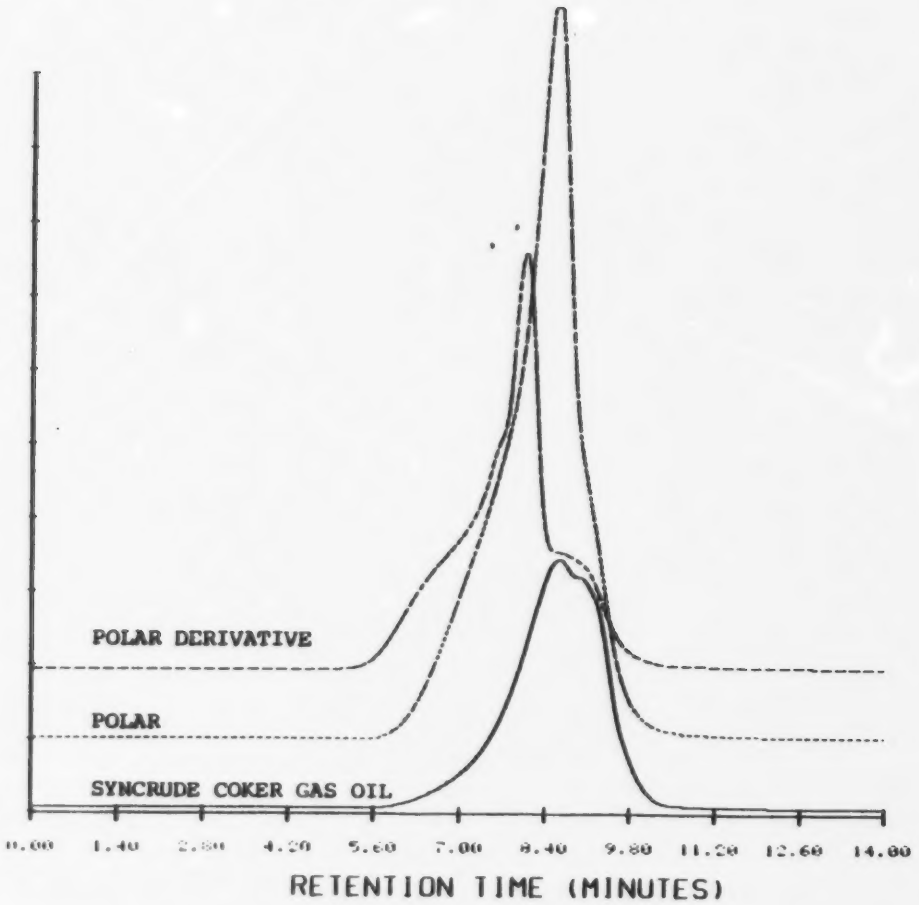


FIGURE 3

GEL PERMEATION CHROMATOGRAPHY OF SYNCRUDE COKER GAS OIL SAMPLES

- raw gas oil
- polar concentrate
- derivatized polars

APPENDIX 1

ANALYSIS AND YIELD DATA FROM THE CATALYTIC CRACKING MICROREACTOR RUNS FOR BLENDS AND DERIVIATIZATION PRODUCTS

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD37

Date of Run 87-05-28
Catalyst Type DA 440
Fresh Feed ATH-D87
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.03	0.00	0.000	0.000
Hydrogen Sulphide	1.79	0.00	0.023	0.000
Methane	0.45	0.00	0.006	0.000
Ethane	0.51	0.00	0.007	0.000
Ethylene	0.52	0.00	0.007	0.000
Propane	1.12	2.20	0.014	0.028
Propylene	3.03	5.81	0.039	0.075
i-Butane	4.56	8.10	0.058	0.105
n-Butane	1.73	2.97	0.022	0.038
C4 Olefins	3.15	5.17	0.040	0.067
i-Pentane	4.87	7.80	0.062	0.101
n-Pentane	0.40	0.64	0.005	0.008
C5 Olefins	1.26	1.91	0.016	0.025
C6+ Gasoline (216C EP)	43.18	55.36	0.552	0.717
LCO (216C-343C Cut)	16.16	17.38	0.206	0.225
Decant (343C+ Cut)	5.56	5.40	0.071	0.070
Coke Make	11.67		0.149	
REL & REG OVERALL YIELDS				
Effluent Liquid	63.89			
Effluent Gas (meas.)	24.63			
Effluent Gas (calc.)	0.00			
Conversion	78.28	77.22		

Catalyst Charge g : 2.238
Fresh Feed g : 0.904
Catalyst to Oil : 2.475
Coke on Catalyst : 3.531

Liquid SV, W/(W.hr) : 11.2
Gas SV, V/(V.sec) : 0.72

MASS BALANCE (mass% FF) : 97.26 Analytical
97.06 Flow

06-01-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD10

Date of Run 87-05-05
Catalyst Type DA 440
Fresh Feed SYN CGOB
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	1.42	0.078	1-Butene	3.53	1.346
Carbon Monoxide	0.00	0.000	2-Methylpropene	0.00	0.000
Nitrogen	73.51	0.000	trans-2-Butene	2.93	1.119
Hydrogen Sulphide	9.10	2.111	cis-2-Butene	2.15	0.821
Carbon Dioxide	0.90	0.270	i-Pentane	12.81	6.291
Methane	7.93	0.866	n-Pentane	1.08	0.530
Ethane	4.08	0.835	1-Pentene	0.18	0.086
Ethylene	5.71	1.090	2-Methyl-1-Butene	0.29	0.136
Propane	7.55	2.266	trans-2-Pentene	0.43	0.205
Propene	14.49	4.150	cis-2-Pentene	0.50	0.239
i-Butane	15.83	6.263	2-Methyl-2-Butene	0.72	0.344
n-Butane	4.54	1.796	C6+	5.25	3.324

Total Moles :174.93

Molar Mass : 33.18
Hydrocarbon : 47.54

RUN CONDITIONS

Room Temperature :	24.5	Catalyst Charge g:	4.2085
Atm. Press. mmHg:	759.3	Fresh Feed g:	0.8085
Gas Volume mL:	414.0	Reactor Liquid g:	0.4358
Cat. Bed Temp. :	510.0	Injection Time s:	55.1000
Carbon on Cat. :	2.13	Feed Density g/mL:	0.8000
N2 Flow ml/min:	20.4		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.000	C5 n-Paraffin :	0.190
C4 n-Paraffin :	0.000	C5 Olefin :	0.740
C4 Olefin :	0.000	IBP-216 EP :	58.700
C5 i-Paraffin :	0.360	IBP-343 EP :	85.600

05-06-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD10

Date of Run 87-05-05
Catalyst Type DA 440
Fresh Feed SYN CGOB
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.08	0.00	0.001	0.000
Hydrogen Sulphide	2.11	0.00	0.027	0.000
Methane	0.87	0.00	0.011	0.000
Ethane	0.84	0.00	0.011	0.000
Ethylene	1.09	0.00	0.014	0.000
Propane	2.27	3.57	0.029	0.044
Propylene	4.15	6.36	0.053	0.078
i-Butane	6.26	8.90	0.081	0.109
n-Butane	1.80	2.46	0.023	0.030
C4 Olefins	3.29	4.31	0.042	0.053
i-Pentane	6.49	8.31	0.083	0.102
n-Pentane	0.63	0.80	0.008	0.010
C5 Olefins	1.41	1.72	0.018	0.021
C6+ Gasoline (216C EP)	34.27	35.15	0.441	0.432
LCO (216C-343C Cut)	15.04	12.94	0.193	0.159
Decant (343C+ Cut)	7.22	5.61	0.093	0.069
Coke Make	12.20		0.157	
REL & REG OVERALL YIELDS				
Effluent Liquid	53.90			
Effluent Gas (meas.)	26.15			
Effluent Gas (calc.)	33.90			
Conversion	77.74	81.45		

Catalyst Charge g : 4.209
Fresh Feed g : 0.809
Catalyst to Oil : 5.205
Coke on Catalyst : 2.343

Liquid SV, W/(W.hr) : 12.3
Gas SV, V/(V.sec) : 0.63

MASS BALANCE (mass% FF) : 92.25 Analytical
92.26 Flow

05-08-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD11

Date of Run 87-05-06
Catalyst Type DA 440
Fresh Feed LLOYDMIN
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.08	0.00	0.001	0.000
Hydrogen Sulphide	2.02	0.00	0.023	0.000
Methane	1.09	0.00	0.012	0.000
Ethane	0.93	0.00	0.010	0.000
Ethylene	1.08	0.00	0.012	0.000
Propane	3.07	4.84	0.035	0.053
Propylene	3.66	5.61	0.041	0.062
i-Butane	7.70	10.94	0.087	0.121
n-Butane	2.49	3.41	0.028	0.038
C4 Olefins	2.26	2.97	0.025	0.033
i-Pentane	8.07	10.33	0.091	0.114
n-Pentane	0.75	0.95	0.008	0.010
C5 Olefins	0.63	0.77	0.007	0.008
C6+ Gasoline (216C EP)	32.27	33.10	0.363	0.365
LCO (216C-343C Cut)	8.63	7.42	0.097	0.082
Decant (343C+ Cut)	2.49	1.94	0.028	0.021
Coke Make	22.78		0.256	
REL & REG OVERALL YIELDS				
Effluent Liquid	39.57			
Effluent Gas (meas.)	32.56			
Effluent Gas (calc.)	37.65			
Conversion	88.88	90.64		

Catalyst Charge g : 4.239
Fresh Feed g : 0.649
Catalyst to Oil : 6.533
Coke on Catalyst : 3.487

Liquid SV, W/(W.hr) : 9.8
Gas SV, V/(V.sec) : 0.57

MASS BALANCE (mass% FF) : 94.91 Analytical
94.91 Flow

05-08-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD11

Date of Run 87-05-06
Catalyst Type DA 440
Fresh Feed LLOYDMIN
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	YIELD Mass %	YIELD Vol. %	YIELD/CONVERSION m/m	YIELD/CONVERSION V/V
Hydrogen :	0.03	0.00	0.001	0.000
Hydrogen Sulphide :	2.02	0.00	0.023	0.000
Methane :	1.09	0.00	0.012	0.000
Ethane :	0.93	0.00	0.010	0.000
Ethylene :	1.08	0.00	0.012	0.000
Propane :	3.07	4.84	0.035	0.053
Propylene :	3.66	5.61	0.041	0.062
i-Butane :	7.70	10.94	0.087	0.121
n-Butane :	2.49	3.41	0.028	0.038
C4 Olefins :	2.26	2.97	0.025	0.033
i-Pentane :	8.07	10.33	0.091	0.114
n-Pentane :	0.75	0.95	0.008	0.010
C5 Olefins :	0.63	0.77	0.007	0.008
C6+ Gasoline (216C EP):	32.27	33.10	0.363	0.365
LCO (216C-343C Cut):	8.63	7.42	0.097	0.082
Decant (343C+ Cut):	2.49	1.94	0.028	0.021
Coke Make :	22.73		0.256	
REL & REG OVERALL YIELDS				
Effluent Liquid :	39.57			
Effluent Gas (meas.) :	39.56			
Effluent Gas (calc.) :	37.65			
Conversion :	88.88	90.64		

Catalyst Charge g : 4.239
Fresh Feed g : 0.649
Catalyst to Oil : 6.533
Coke on Catalyst : 3.487

Liquid SV, W/(W.hr) : 9.8
Gas SV, V/(V.sec) : 0.53

MASS BALANCE (mass% FF) : 94.91 Analytical
94.91 Flow

05-08-19-7

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD12

Date of Run 87-05-06
Catalyst Type DA 440
Fresh Feed ATHB+SGO
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	1.54	0.094	1-Butene	2.73	1.262
Carbon Monoxide	0.00	0.000	2-Methylpropene	0.00	0.000
Nitrogen	71.26	0.000	trans-2-Butene	2.36	1.091
Hydrogen Sulphide	9.24	2.594	cis-2-Butene	1.71	0.790
Carbon Dioxide	0.84	0.305	i-Pentane	14.06	8.357
Methane	8.92	1.179	n-Pentane	1.11	0.660
Ethane	4.15	1.028	1-Pentene	0.12	0.069
Ethylene	5.15	1.190	2-Methyl-1-Butene	0.13	0.075
Propane	8.23	2.990	trans-2-Pentene	0.11	0.064
Propene	12.92	4.479	cis-2-Pentene	0.02	0.012
i-Butane	17.05	8.164	2-Methyl-2-Butene	0.49	0.283
n-Butane	5.28	2.528	C6+	5.38	4.122

Total Moles :172.80

Molar Mass : 33.61
Hydrocarbon : 47.51

RUN CONDITIONS

Room Temperature :	24.5	Catalyst Charge g:	4.2378
Atm. Press. mmHg:	753.0	Fresh Feed g:	0.8413
Gas Volume mL:	449.0	Reactor Liquid g:	0.3847
Cat. Bed Temp. :	510.0	Injection Time s:	56.0700
Carbon on Cat. :	2.39	Feed Density g/mL:	0.8000
N2 Flow ml/min:	21.4		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.000	C5 n-Paraffin :	0.270
C4 n-Paraffin :	0.000	C5 Olefin :	1.070
C4 Olefin :	0.000	IBP-216 EP :	70.600
C5 i-Paraffin :	0.250	IBP-343 EP :	93.000

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD12

Date of Run 87-05-06
Catalyst Type DA 440
Fresh Feed ATHB+SGO
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen :	0.09	0.00	0.001	0.000
Hydrogen Sulphide :	2.59	0.00	0.030	0.000
Methane :	1.18	0.00	0.014	0.000
Ethane :	1.03	0.00	0.012	0.000
Ethylene :	1.19	0.00	0.014	0.000
Propane :	2.99	4.71	0.035	0.053
Propylene :	4.48	6.86	0.052	0.077
i-Butane :	8.16	11.60	0.094	0.131
n-Butane :	2.53	3.46	0.029	0.039
C4 Olefins :	3.14	4.12	0.036	0.046
i-Pentane :	8.47	10.85	0.098	0.122
n-Pentane :	0.78	0.99	0.009	0.011
C5 Olefins :	0.99	1.21	0.011	0.014
C6+ Gasoline (216C EP):	35.68	36.59	0.412	0.413
LCO (216C-343C Cut):	10.24	8.81	0.118	0.099
Decant (343C+ Cut):	3.20	2.49	0.037	0.028
Coke Make :	13.24		0.153	
REL & REG OVERALL YIELDS				
Effluent Liquid :	45.73			
Effluent Gas (meas.) :	29.33			
Effluent Gas (calc.) :	41.03			
Conversion :	86.56	88.70		

Catalyst Charge g : 4.238
Fresh Feed g : 0.841
Catalyst to Oil : 5.037
Coke on Catalyst : 2.629

Liquid SV, W/(W.hr) : 12.7
Gas SV, V/(V.sec) : 0.65

MASS BALANCE (mass% FF) : 88.30 Analytical
88.30 Flow

05-08-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD15

Date of Run 87-05-11
Catalyst Type DA 440
Fresh Feed SYN-BLEND
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.70	0.021	1-Butene	3.63	0.5[illegible]
Carbon Monoxide	0.00	0.000	2-Methylpropene	2.43	0.3[illegible]
Nitrogen	80.51	0.000	trans-2-Butene	4.30	0.6[illegible]
Hydrogen Sulphide	12.09	1.162	cis-2-Butene	3.14	0.4[illegible]
Carbon Dioxide	0.00	0.000	i-Pentane	11.00	2.[illegible]
Methane	4.75	0.215	n-Pentane	0.64	0.1[illegible]
Ethane	3.29	0.279	1-Pentene	0.44	0.0[illegible]
Ethylene	4.57	0.362	2-Methyl-1-Butene	0.43	0.0[illegible]
Propane	4.60	0.372	trans-2-Pentene	1.[illegible]	0.[illegible]
Propene	17.75	2.107	cis-2-Pentene	0.90	0.1[illegible]
i-Butane	14.86	2.436	2-Methyl-2-Butene	1.[illegible]	0.[illegible]
n-Butane	2.96	0.485	C6+	5.64	1.[illegible]

Total Moles :161.21

Molar Mass : 32.20
Hydrocarbon : 49.51

RUN CONDITIONS

Room Temperature	: 25.0		Catalyst Charge g:	2.1077
Atm. Press.	mmHg: 748.7		Fresh Feed g:	1.0082
Gas Volume	mL: 363.0		Reactor Liquid g:	0.7458
Cat. Bed Temp.	: 490.0		Injection Time s:	120.1000
Carbon on Cat.	: 2.60		Feed Density g/mL:	1.0000
N2 Flow	ml/min: 20.7			

REACTOR EFFLUENT LIQUID

C4 i-Paraffin	: 0.010	C5 n-Paraffin	: 0.150
C4 n-Paraffin	: 0.000	C5 Olefin	: 0.620
C4 Olefin	: 0.010	IBP-216 EP	: 42.300
C5 i-Paraffin	: 0.580	IBP-343 EP	: 72.200

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD15

Date of Run 87-05-11
Catalyst Type DA 440
Fresh Feed SYN-BLEND
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.16	0.00	0.020	0.000
Methane	0.21	0.00	0.004	0.000
Ethane	0.28	0.00	0.005	0.000
Ethylene	0.36	0.00	0.006	0.000
Propane	0.57	1.13	0.010	0.020
Propylene	2.11	4.04	0.037	0.072
i-Butane	2.44	4.34	0.043	0.077
n-Butane	0.49	0.83	0.008	0.015
C4 Olefins	2.14	3.51	0.037	0.062
i-Pentane	2.67	4.27	0.047	0.076
n-Pentane	0.28	0.45	0.005	0.008
C5 Olefins	1.28	1.95	0.022	0.035
C6+ Gasoline (216C EP)	31.76	40.71	0.554	0.724
LCO (216C-343C Cut)	22.12	23.78	0.386	0.423
Decant (343C+ Cut)	20.56	19.97	0.359	0.355
Coke Make	11.54		0.201	
REL & REG OVERALL YIELDS				
Effluent Liquid	73.97			
Effluent Gas (meas.)	14.76			
Effluent Gas (calc.)	0.00			
Conversion	57.32	56.25		

Catalyst Charge g : 2.108
Fresh Feed g : 1.008
Catalyst to Oil : 2.091
Coke on Catalyst : 2.860

Liquid SV, W/(W.hr) : 13.2
Gas SV, V/(V.sec) : 0.81

MASS BALANCE (mass% FF) : 94.71 Analytical
94.44 Flow

05-29-198

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD16

Date of Run 87-05-11
Catalyst Type DA 440
Fresh Feed LLOYD-BLEND
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.97	0.034	1-Butene	2.47	0.639
Carbon Monoxide	0.00	0.000	2-Methylpropene	1.65	0.427
Nitrogen	72.32	0.000	trans-2-Butene	3.63	0.939
Hydrogen Sulphide	10.57	1.662	cis-2-Butene	2.61	0.676
Carbon Dioxide	0.00	0.000	i-Pentane	12.92	4.300
Methane	6.62	0.490	n-Pentane	1.01	0.336
Ethane	3.91	0.542	1-Pentene	0.20	0.065
Ethylene	3.98	0.515	2-Methyl-1-Butene	0.29	0.094
Propane	5.70	1.159	trans-2-Pentene	0.42	0.136
Propene	16.15	3.135	cis-2-Pentene	0.45	0.144
i-Butane	17.56	4.708	2-Methyl-2-Butene	0.67	0.217
n-Butane	4.19	1.123	C6+	4.99	2.141

Total Moles : 173.29

Molar Mass : 33.86
Hydrocarbon : 49.13

RUN CONDITIONS

Room Temperature :	25.0	Catalyst Charge g:	2.1051
Atm. Press. mmHg:	748.2	Fresh Feed g:	0.9302
Gas Volume mL:	400.0	Reactor Liquid g:	0.5851
Cat. Bed Temp: :	490.0	Injection Time s:	130.1000
C[illegible] on Cat. :	2.76	Feed Density g/mL:	1.0000
N2 [illegible] ml/min:	19.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.020	C5 n-Paraffin :	0.790
C4 n-Paraffin :	0.030	C5 Olefin :	1.540
C4 Olefin :	0.090	IBP-216 EP :	68.400
C5 i-Paraffin :	1.940	IBP-343 EP :	91.500

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD16

Date of Run 87-05-11
Catalyst Type DA 440
Fresh Feed LLOYD-BLEND
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen :	0.03	0.00	0.000	0.000
Hydrogen Sulphide :	1.66	0.00	0.021	0.000
Methane :	0.49	0.00	0.006	0.000
Ethane :	0.54	0.00	0.007	0.000
Ethylene :	0.51	0.00	0.006	0.000
Propane :	1.16	2.28	0.014	0.029
Propylene :	3.13	6.01	0.039	0.076
i-Butane :	4.72	8.38	0.059	0.106
n-Butane :	1.14	1.95	0.014	0.025
C4 Olefins :	2.74	4.49	0.034	0.057
i-Pentane :	5.52	8.84	0.069	0.112
n-Pentane :	0.58	0.92	0.007	0.012
C5 Olefins :	1.63	2.48	0.020	0.031
C6+ Gasoline (216C EP):	42.64	54.67	0.532	0.690
LCO (216C-343C Cut):	14.53	15.62	0.181	0.197
Decant (343C+ Cut):	5.35	5.19	0.067	0.066
Coke Make :	13.61		0.170	
REL & REG OVERALL YIELDS				
Effluent Liquid :	62.90			
Effluent Gas (meas.) :	23.53			
Effluent Gas (calc.) :	0.00			
Conversion :	80.12	79.19		

Catalyst Charge g : 2.105
Fresh Feed g : 0.930
Catalyst to Oil : 2.263
Coke on Catalyst : 3.036

Liquid SV, W/(W.hr) : 12.2
Gas SV, V/(V.sec) : 0.75

MASS BALANCE (mass% FF) : 93.30 Analytical
93.26 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD17

Date of Run 87-05-12
Catalyst Type DA 440
Fresh Feed ATH-BLEND
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.80	0.027	1-Butene	2.61	0.592
Carbon Monoxide	0.42	0.048	2-Methylpropene	1.74	0.395
Nitrogen	74.96	0.000	trans-2-Butene	3.63	0.823
Hydrogen Sulphide	12.02	1.656	cis-2-Butene	2.61	0.592
Carbon Dioxide	0.09	0.016	i-Pentane	12.53	3.654
Methane	5.92	0.384	n-Pentane	0.94	0.274
Ethane	3.58	0.435	1-Pentene	0.31	0.088
Ethylene	3.86	0.438	2-Methyl-1-Butene	0.39	0.111
Propane	5.61	1.000	trans-2-Pentene	0.51	0.145
Propene	15.63	2.658	cis-2-Pentene	0.78	0.221
i-Butane	16.68	3.918	2-Methyl-2-Butene	0.96	0.272
n-Butane	3.87	0.909	C6+	5.31	1.996

Total Moles :175.76

Molar Mass : 33.38
Hydrocarbon : 49.55

RUN CONDITIONS

Room Temperature	23.5	Catalyst Charge g:	2.1698
Atm. Press. mmHg:	756.3	Fresh Feed g:	0.9766
Gas Volume mL:	409.0	Reactor Liquid g:	0.6014
Cat. Bed Temp.	490.0	Injection Time s:	130.0000
Carbon on Cat.	3.18	Feed Density g/mL:	1.0000
N2 Flow ml/min:	20.7		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin	0.020	C5 n-Paraffin	0.210
C4 n-Paraffin	0.010	C5 Olefin	0.850
C4 Olefin	0.080	IBP-216 EP	64.500
C5 i-Paraffin	1.530	IBP-343 EP	90.100

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD17

Date of Run 87-05-12
Catalyst Type DA 440
Fresh Feed ATH-BLEND
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen :	0.03	0.00	0.000	0.000
Hydrogen Sulpride :	1.66	0.00	0.021	0.000
Methane :	0.38	0.00	0.005	0.000
Ethane :	0.44	0.00	0.006	0.000
Ethylene :	0.44	0.00	0.006	0.000
Propane :	1.00	1.97	0.013	0.026
Propylene :	2.66	5.09	0.034	0.066
i-Butane :	3.93	6.98	0.050	0.090
n-Butane :	0.92	1.57	0.012	0.020
C4 Olefins :	2.45	4.02	0.031	0.052
i-Pentane :	4.60	7.36	0.059	0.095
n-Pentane :	0.40	0.64	0.005	0.008
C5 Olefins :	1.36	2.07	0.017	0.027
C6+ Gasoline (216C EP):	40.11	51.43	0.513	0.666
LCO (216C-343C Cut):	15.70	16.89	0.201	0.219
Decant (343C+ Cut):	6.10	5.92	0.078	0.077
Coke Make :	17.83		0.228	
REL & REG OVERALL YIELDS				
Effluent Liquid :	61.58			
Effluent Gas (meas.) :	21.14			
Effluent Gas (calc.) :	0.00			
Conversion :	78.20	77.20		

Catalyst Charge g : 2.170
Fresh Feed g : 0.977
Catalyst to Oil : 2.222
Coke on Catalyst : 3.498

Liquid SV, W/(W.hr) : 12.5
Gas SV, V/(V.sec) : 0.77

MASS BALANCE (mass% FF) : 90.49 Analytical
89.94 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD18

Date of Run 87-05-13
Catalyst Type DA 440
Fresh Feed SYN-DB1
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.73	0.022	1-Butene	3.61	0.615
Carbon Monoxide	0.00	0.000	2-Methylpropene	2.16	0.368
Nitrogen	78.68	0.000	trans-2-Butene	4.20	0.715
Hydrogen Sulphide	11.88	1.228	cis-2-Butene	3.02	0.514
Carbon Dioxide	0.00	0.000	i-Pentane	10.72	2.347
Methane	5.23	0.255	n-Pentane	0.86	0.188
Ethane	3.37	0.307	1-Pentene	0.45	0.096
Ethylene	4.54	0.386	2-Methyl-1-Butene	0.47	0.100
Propane	4.78	0.640	trans-2-Pentene	0.98	0.209
Propene	17.83	2.277	cis-2-Pentene	1.08	0.230
i-Butane	15.04	2.652	2-Methyl-2-Butene	1.41	0.300
n-Butane	3.01	0.531	C6+	5.36	1.513

Total Moles :179.41

Molar Mass : 32.55
Hydrocarbon : 49.31

RUN CONDITIONS

Room Temperature :	23.8	Catalyst Charge g:	2.1680
Atm. Press. mmHg:	759.6	Fresh Feed g:	1.0118
Gas Volume mL:	370.0	Reactor Liquid g:	0.7708
Cat. Bed Temp. :	490.0	Injection Time s:	130.0000
Carbon on Cat. :	2.23	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.5		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.010	C5 n-Paraffin :	0.180
C4 n-Paraffin :	0.010	C5 Olefin :	0.740
C4 Olefin :	0.040	IBP-216 EP :	44.500
C5 i-Paraffin :	0.750	IBP-343 EP :	74.000

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD18

Date of Run 87-05-13
Catalyst Type DA 440
Fresh Feed SYN-DB1
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	YIELD Mass %	YIELD Vol. %	YIELD/CONVERSION m/m	YIELD/CONVERSION V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.23	0.00	0.021	0.000
Methane	0.25	0.00	0.004	0.000
Ethane	0.31	0.00	0.005	0.000
Ethylene	0.39	0.00	0.007	0.000
Propane	0.64	1.26	0.011	0.022
Propylene	2.28	4.36	0.039	0.077
i-Butane	2.66	4.72	0.046	0.083
n-Butane	0.54	0.92	0.009	0.016
C4 Olefins	2.24	3.68	0.039	0.065
i-Pentane	2.92	4.67	0.051	0.083
n-Pentane	0.33	0.52	0.006	0.009
C5 Olefins	1.50	2.28	0.026	0.040
C6+ Gasoline (216C EP)	34.10	43.71	0.591	0.772
LCO (216C-343C Cut)	22.47	24.16	0.389	0.427
Decant (343C+ Cut)	19.81	19.23	0.343	0.340
Coke Make	8.33		0.144	
REL & REG OVERALL YIELDS				
Effluent Liquid	76.18			
Effluent Gas (meas.)	15.77			
Effluent Gas (calc.)	0.00			
Conversion	57.72	56.60		

Catalyst Charge g : 2.168
Fresh Feed g : 1.012
Catalyst to Oil : 2.143
Coke on Catalyst : 2.453

Liquid SV, W/(W.hr) : 12.9
Gas SV, V/(V.sec) : 0.77

MASS BALANCE (mass% FF) : 97.21 Analytical
96.93 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD19

Date of Run 87-05-13
Catalyst Type DA 440
Fresh Feed LLOYD-DB1
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.58	0.021	1-Butene	2.71	0.675
Carbon Monoxide	0.38	0.047	2-Methylpropene	1.80	0.448
Nitrogen	74.38	0.000	trans-2-Butene	3.85	0.959
Hydrogen Sulphide	10.76	1.628	cis-2-Butene	2.75	0.685
Carbon Dioxide	0.18	0.035	i-Pentane	12.63	4.044
Methane	6.29	0.448	n-Pentane	0.95	0.304
Ethane	3.62	0.483	1-Pentene	0.35	0.109
Ethylene	3.81	0.474	2-Methyl-1-Butene	0.39	0.121
Propane	5.42	1.061	trans-2-Pentene	0.68	0.212
Propene	15.94	2.977	cis-2-Pentene	0.77	0.240
i-Butane	16.60	4.282	2-Methyl-2-Butene	0.95	0.295
n-Butane	3.82	0.985	C6+	5.35	2.208

Total Moles :174.96

Molar Mass : 33.66
Hydrocarbon : 50.17

RUN CONDITIONS

Room Temperature :	23.5	Catalyst Charge g:	2.1051
Atm. Press. mmHg:	753.8	Fresh Feed g:	0.9428
Gas Volume mL:	418.0	Reactor Liquid g:	0.5937
Cat. Bed Temp. :	490.0	Injection Time s:	130.1000
Carbon on Cat. :	3.03	Feed Density g/mL:	1.0000
N2 Flow ml/min:	20.9		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.010	C5 n-Paraffin :	0.220
C4 n-Paraffin :	0.020	C5 Olefin :	0.900
C4 Olefin :	0.060	IBP-216 EP :	66.200
C5 i-Paraffin :	1.590	IBP-343 EP :	90.600

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD19

Date of Run 87-05-13
Catalyst Type DA 440
Fresh Feed LLOYD-DB1
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.63	0.00	0.021	0.000
Methane	0.45	0.00	0.006	0.000
Ethane	0.48	0.00	0.006	0.000
Ethylene	0.47	0.00	0.006	0.000
Propane	1.06	2.09	0.013	0.027
Propylene	2.98	5.70	0.038	0.073
i-Butane	4.29	7.62	0.054	0.098
n-Butane	1.00	1.71	0.013	0.022
C4 Olefins	2.80	4.60	0.036	0.059
i-Pentane	5.05	8.08	0.064	0.104
n-Pentane	0.44	0.70	0.006	0.009
C5 Olefins	1.54	2.35	0.020	0.030
C6+ Gasoline (216C EP)	42.13	54.02	0.535	0.695
LCO (216C-343C Cut)	15.37	16.52	0.195	0.213
Decant (343C+ Cut)	5.92	5.75	0.075	0.074
Coke Make	14.37		0.183	
REL & REG OVERALL YIELDS				
Effluent Liquid	62.97			
Effluent Gas (meas.)	23.09			
Effluent Gas (calc.)	0.00			
Conversion	78.72	77.73		

Catalyst Charge g : 2.105
Fresh Feed g : 0.943
Catalyst to Oil : 2.233
Coke on Catalyst : 3.333

Liquid SV, W/(W.hr) : 12.4
Gas SV, V/(V.sec) : 0.78

MASS BALANCE (mass% FF) : 93.51 Analytical
93.07 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD20

Date of Run 87-05-14
Catalyst Type DA 440
Fresh Feed ATH-DB1
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.69	0.022	1-Butene	2.74	0.595
Carbon Monoxide	0.38	0.041	2-Methylpropene	1.82	0.395
Nitrogen	75.21	0.000	trans-2-Butene	3.73	0.810
Hydrogen Sulphide	11.92	1.573	cis-2-Butene	2.67	0.580
Carbon Dioxide	0.17	0.029	i-Pentane	11.94	3.335
Methane	6.60	0.410	n-Pentane	0.97	0.271
Ethane	3.77	0.439	1-Pentene	0.26	0.071
Ethylene	3.87	0.420	2-Methyl-1-Butene	0.25	0.068
Propane	5.42	0.925	trans-2-Pentene	0.56	0.152
Propene	15.85	2.582	cis-2-Pentene	1.00	0.272
i-Butane	16.34	3.677	2-Methyl-2-Butene	0.93	0.253
n-Butane	3.70	0.833	C6+	5.11	1.840

Total Moles : 175.90

Molar Mass : 33.26
Hydrocarbon : 49.29

RUN CONDITIONS

Room Temperature :	24.5	Catalyst Charge g:	2.1000
Atm. Press. mmHg:	752.6	Fresh Feed g:	0.9979
Gas Volume mL:	396.0	Reactor Liquid g:	0.6349
Cat. Bed Temp. :	490.0	Injection Time s:	130.1000
Carbon on Cat. :	3.85	Feed Density g/mL:	1.0000
N2 [illegible] ml/min:	19.9		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.020	C5 n-Paraffin :	0.280
C4 n-Paraffin :	0.020	C5 Olefin :	1.110
C4 Olefin :	0.080	IBP-216 EP :	63.800
C5 i-Paraffin :	1.560	IBP-343 EP :	89.800

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD20

Date of Run 87-05-14
Catalyst Type DA 440
Fresh Feed ATH-DB1
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

		---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	:	0.02	0.00	0.000	0.000
Hydrogen Sulphide	:	1.57	0.00	0.020	0.000
Methane	:	0.41	0.00	0.005	0.000
Ethane	:	0.44	0.00	0.006	0.000
Ethylene	:	0.42	0.00	0.005	0.000
Propane	:	0.93	1.82	0.012	0.024
Propylene	:	2.58	4.95	0.034	0.065
i-Butane	:	3.69	6.55	0.048	0.086
n-Butane	:	0.85	1.45	0.011	0.019
C4 Olefins	:	2.43	3.99	0.032	0.053
i-Pentane	:	4.33	6.93	0.056	0.091
n-Pentane	:	0.45	0.71	0.006	0.009
C5 Olefins	:	1.52	2.31	0.020	0.030
C6+ Gasoline (216C EP)	:	40.48	51.90	0.526	0.684
LCO (216C-343C Cut)	:	16.54	17.79	0.215	0.234
Decant (343C+ Cut)	:	6.49	6.30	0.084	0.083
Coke Make	:	16.85		0.219	
REL & REG OVERALL YIELDS					
Effluent Liquid	:	63.62			
Effluent Gas (meas.)	:	19.55			
Effluent Gas (calc.)	:	0.00			
Conversion	:	76.97	75.91		

Catalyst Charge g : 2.100
Fresh Feed g : 0.998
Catalyst to Oil : 2.104
Coke on Catalyst : 4.235

Liquid SV, W/(W.hr) : 13.1
Gas SV, V/(V.sec) : 0.79

MASS BALANCE (mass% FF) : 92.09 Analytical
92.06 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD21

Date of Run 87-05-15
Catalyst Type DA 440
Fresh Feed LLOYD-DB2
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.77	0.031	1-Butene	2.42	0.662
Carbon Monoxide	0.00	0.000	2-Methylpropene	1.62	0.443
Nitrogen	74.51	0.000	trans-2-Butene	3.60	0.984
Hydrogen Sulphide	10.94	1.817	cis-2-Butene	2.61	0.714
Carbon Dioxide	0.00	0.000	i-Pentane	13.27	4.665
Methane	6.42	0.502	n-Pentane	1.05	0.369
Ethane	3.77	0.552	1-Pentene	0.38	0.130
Ethylene	3.87	0.529	2-Methyl-1-Butene	0.36	0.123
Propane	5.75	1.235	trans-2-Pentene	0.49	0.167
Propene	15.62	3.202	cis-2-Pentene	0.59	0.202
i-Butane	16.81	4.760	2-Methyl-2-Butene	0.85	0.290
n-Butane	4.07	1.153	C6+	5.51	2.497

Total Moles :175.28

Molar Mass : 33.57
Hydrocarbon : 49.81

RUN CONDITIONS

Room Temperature :	23.0	Catalyst Charge g:	2.1214
Atm. Press. mmHg:	755.7	Fresh Feed g:	0.8633
Gas Volume mL:	421.0	Reactor Liquid g:	0.5431
Cat. Bed Temp. :	490.0	Injection Time s:	129.9600
Carbon on Cat. :	2.71	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.0		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.020	C5 n-Paraffin :	0.190
C4 n-Paraffin :	0.010	C5 Olefin :	0.790
C4 Olefin :	0.080	IBP-216 EP :	68.700
C5 i-Paraffin :	1.710	IBP-343 EP :	91.600

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD21

Date of Run 87-05-15
Catalyst Type DA 440
Fresh Feed LLOYD-DB2
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.03	0.00	0.000	0.000
Hydrogen Sulphide	1.82	0.00	0.023	0.000
Methane	0.50	0.00	0.006	0.000
Ethane	0.55	0.00	0.007	0.000
Ethylene	0.53	0.00	0.007	0.000
Propane	1.24	2.43	0.015	0.031
Propylene	3.20	6.14	0.040	0.077
i-Butane	4.77	8.48	0.059	0.107
n-Butane	1.16	1.98	0.014	0.025
C4 Olefins	2.85	4.68	0.036	0.059
i-Pentane	5.74	9.19	0.071	0.116
n-Pentane	0.49	0.77	0.006	0.010
C5 Olefins	1.41	2.15	0.018	0.027
C6+ Gasoline (216C EP)	43.95	56.35	0.547	0.710
LCO (216C-343C Cut)	14.41	15.49	0.179	0.195
Decant (343C+ Cut)	5.28	5.13	0.066	0.065
Coke Make	12.06		0.150	
REL & REG OVERALL YIELDS				
Effluent Liquid	62.91			
Effluent Gas (meas.)	25.34			
Effluent Gas (calc.)	0.00			
Conversion	80.31	79.38		

Catalyst Charge g : 2.121
Fresh Feed g : 0.863
Catalyst to Oil : 2.457
Coke on Catalyst : 2.981

Liquid SV, W/(W.hr) : 11.3
Gas SV, V/(V.sec) : 0.74

MASS BALANCE (mass% FF) : 95.57 Analytical
95.26 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD22

Date of Run 87-05-19
Catalyst Type DA 440
Fresh Feed ATH-DB2
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed
Hydrogen	0.99	0.034
Carbon Monoxide	0.49	0.064
Nitrogen	71.56	0.000
Hydrogen Sulphide	12.29	1.959
Carbon Dioxide	0.17	0.035
Methane	7.10	0.533
Ethane	4.29	0.603
Ethylene	4.03	0.529
Propane	5.75	1.186
Propene	15.79	3.108
i-Butane	15.97	4.341
n-Butane	3.86	1.049

Total Moles :172.55

Compound	Moles	% Feed
1-Butene	2.52	0.661
2-Methylpropene	1.68	0.441
trans-2-Butene	3.53	0.926
cis-2-Butene	2.54	0.667
i-Pentane	11.84	3.996
n-Pentane	0.95	0.321
1-Pentene	0.25	0.082
2-Methyl-1-Butene	0.34	0.112
trans-2-Pentene	0.50	0.164
cis-2-Pentene	0.55	0.180
2-Methyl-2-Butene	0.72	0.236
C6+	4.84	2.105

Molar Mass : 33.74
Hydrocarbon : 48.25

RUN CONDITIONS

Room Temperature	23.0	Catalyst Charge g:	2.1834
Atm. Press. mmHg:	755.6	Fresh Feed g:	0.9686
Gas Volume mL:	402.0	Reactor Liquid g:	0.6261
Cat. Bed Temp. :	490.0	Injection Time s:	130.1000
Carbon on Cat. :	2.02	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.2		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin	0.050	C5 n-Paraffin	0.250
C4 n-Paraffin	0.040	C5 Olefin	0.990
C4 Olefin	0.130	IBP-216 EP	67.200
C5 i-Paraffin	2.000	IBP-343 EP	90.700

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD22

Date of Run 87-05-19
Catalyst Type DA 440
Fresh Feed ATH-DB2
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	YIELD Mass %	YIELD Vol. %	YIELD/CONVERSION m/m	YIELD/CONVERSION V/V
Hydrogen	0.03	0.00	0.000	0.000
Hydrogen Sulphide	1.96	0.00	0.025	0.000
Methane	0.53	0.00	0.007	0.000
Ethane	0.60	0.00	0.008	0.000
Ethylene	0.53	0.00	0.007	0.000
Propane	1.19	2.34	0.015	0.030
Propylene	3.11	5.95	0.039	0.076
i-Butane	4.37	7.77	0.056	0.100
n-Butane	1.08	1.84	0.014	0.024
C4 Olefins	2.78	4.56	0.035	0.059
i-Pentane	5.29	8.47	0.067	0.109
n-Pentane	0.48	0.76	0.006	0.010
C5 Olefins	1.41	2.15	0.018	0.028
C6+ Gasoline (216C EP)	43.31	55.52	0.550	0.713
LCO (216C-343C Cut)	15.19	16.33	0.193	0.210
Decant (343C+ Cut)	6.01	5.84	0.076	0.075
Coke Make	12.13		0.154	
REL & REG OVERALL YIELDS				
Effluent Liquid	64.64			
Effluent Gas (meas.)	23.15			
Effluent Gas (calc.)	0.00			
Conversion	78.80	77.83		

Catalyst Charge g : 2.183
Fresh Feed g : 0.969
Catalyst to Oil : 2.254
Coke on Catalyst : 2.222

Liquid SV, W/(W.hr) : 12.3
Gas SV, V/(V.sec) : 0.74

MASS BALANCE (mass% FF) : 92.80 Analytical
92.88 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD23

Date of Run 87-05-19
Catalyst Type DA 440
Fresh Feed SYN-DB2
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.56	0.018	1-Butene	3.69	0.592
Carbon Monoxide	0.00	0.000	2-Methylpropene	2.23	0.358
Nitrogen	81.26	0.000	trans-2-Butene	4.22	0.677
Hydrogen Sulphide	12.15	1.185	cis-2-Butene	3.10	0.498
Carbon Dioxide	0.00	0.000	i-Pentane	11.04	2.279
Methane	4.76	0.218	n-Pentane	0.83	0.171
Ethane	3.29	0.283	1-Pentene	0.43	0.086
Ethylene	4.33	0.347	2-Methyl-1-Butene	0.56	0.112
Propane	4.63	0.584	trans-2-Pentene	0.99	0.199
Propene	17.42	2.097	cis-2-Pentene	1.29	0.259
i-Butane	14.80	2.461	2-Methyl-2-Butene	1.55	0.311
n-Butane	3.04	0.505	C6+	5.65	1.507

Total Moles :181.82

Molar Mass : 32.13
Hydrocarbon : 50.00

RUN CONDITIONS

Room Temperature :	23.0	Catalyst Charge g:	2.1286
Atm. Press. mmHg:	755.8	Fresh Feed g:	0.9992
Gas Volume mL:	390.0	Reactor Liquid g:	0.7221
Cat. Bed Temp. :	490.0	Injection Time s:	130.0000
Carbon on Cat. :	2.05	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.2		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.010	C5 n-Paraffin :	0.180
C4 n-Paraffin :	0.010	C5 Olefin :	0.700
C4 Olefin :	0.020	IBP-216 EP :	45.300
C5 i-Paraffin :	0.680	IBP-343 EP :	72.600

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD23

Date of Run 87-05-19
Catalyst Type DA 440
Fresh Feed SYN-DB2
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen :	0.02	0.00	0.000	0.000
Hydrogen Sulphide :	1.18	0.00	0.020	0.000
Methane :	0.22	0.00	0.004	0.000
Ethane :	0.28	0.00	0.005	0.000
Ethylene :	0.35	0.00	0.006	0.000
Propane :	0.58	1.15	0.010	0.019
Propylene :	2.10	4.02	0.035	0.067
i-Butane :	2.47	4.38	0.041	0.074
n-Butane :	0.51	0.88	0.008	0.015
C4 Olefins :	2.14	3.51	0.035	0.059
i-Pentane :	2.77	4.43	0.046	0.074
n-Pentane :	0.30	0.48	0.005	0.008
C5 Olefins :	1.47	2.24	0.024	0.038
C6+ Gasoline (216C EP):	33.08	42.42	0.547	0.712
LCO (216C-343C Cut):	19.73	21.21	0.326	0.356
Decant (343C+ Cut):	19.80	19.22	0.327	0.323
Coke Make :	12.99		0.215	
REL & REG OVERALL YIELDS				
Effluent Liquid :	72.27			
Effluent Gas (meas.) :	14.97			
Effluent Gas (calc.) :	0.00			
Conversion :	60.47	59.56		

Catalyst Charge g : 2.129
Fresh Feed g : 0.999
Catalyst to Oil : 2.130
Coke on Catalyst : 2.255

Liquid SV, W/(W.hr) : 13.0
Gas SV, V/(V.sec) : 0.81

MASS BALANCE (mass% FF) : 92.04 Analytical
91.82 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD24

Date of Run 87-05-20
Catalyst Type DA 440
Fresh Feed SYN-DB3
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.53	0.015	1-Butene	3.62	0.576
Carbon Monoxide	0.49	0.039	2-Methylpropene	2.42	0.385
Nitrogen	79.87	0.000	trans-2-Butene	4.27	0.679
Hydrogen Sulphide	11.92	1.152	cis-2-Butene	3.06	0.487
Carbon Dioxide	0.00	0.000	i-Pentane	10.78	2.205
Methane	4.88	0.222	n-Pentane	0.79	0.162
Ethane	3.16	0.269	1-Pentene	0.40	0.080
Ethylene	4.32	0.344	2-Methyl-1-Butene	0.51	0.101
Propane	4.73	0.591	trans-2-Pentene	0.96	0.191
Propene	17.67	2.108	cis-2-Pentene	1.03	0.205
i-Butane	15.08	2.485	2-Methyl-2-Butene	1.44	0.286
n-Butane	3.14	0.517	C6+	5.33	1.406

Total Moles :180.40

Molar Mass : 32.40
Hydrocarbon : 49.92

RUN CONDITIONS

Room Temperature :	23.0	Catalyst Charge g:	2.1384
Atm. Press. mmHg:	755.0	Fresh Feed g:	1.0085
Gas Volume mL:	361.0	Reactor Liquid g:	0.7709
Cat. Bed Temp. :	490.0	Injection Time s:	130.0600
Carbon on Cat. :	1.92	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.010	C5 n-Paraffin :	0.180
C4 n-Paraffin :	0.010	C5 Olefin :	0.720
C4 Olefin :	0.040	IBP-216 EP :	46.300
C5 i-Paraffin :	0.770	IBP-343 EP :	74.500

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD24

Date of Run 87-05-20
Catalyst Type DA 440
Fresh Feed SYN-DB3
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.15	0.00	0.020	0.000
Methane	0.22	0.00	0.004	0.000
Ethane	0.27	0.00	0.005	0.000
Ethylene	0.34	0.00	0.006	0.000
Propane	0.59	1.16	0.010	0.020
Propylene	2.11	4.04	0.036	0.070
i-Butane	2.49	4.43	0.042	0.076
n-Butane	0.53	0.90	0.009	0.016
C4 Olefins	2.16	3.54	0.037	0.061
i-Pentane	2.79	4.47	0.047	0.077
n-Pentane	0.30	0.47	0.005	0.008
C5 Olefins	1.41	2.15	0.024	0.037
C6+ Gasoline (216C EP)	35.47	45.48	0.602	0.786
LCO (216C-343C Cut)	21.56	23.18	0.366	0.400
Decant (343C+ Cut)	19.49	18.92	0.331	0.327
Coke Make	9.09		0.154	
REL & REG OVERALL YIELDS				
Effluent Liquid	76.44			
Effluent Gas (meas.)	14.63			
Effluent Gas (calc.)	0.00			
Conversion	58.95	57.90		

Catalyst Charge g : 2.138
Fresh Feed g : 1.009
Catalyst to Oil : 2.120
Coke on Catalyst : 2.112 x 2.12 = 4.48 %

Liquid SV, W/(W.hr) : 13.1
Gas SV, V/(V.sec) : 0.78

MASS BALANCE (mass% FF) : 95.55 Analytical
95.39 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD25

Date of Run 87-05-20
Catalyst Type DA 440
Fresh Feed LLOYD-DB3
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.43	0.016	1-Butene	2.92	0.771
Carbon Monoxide	0.00	0.000	2-Methylpropene	1.94	0.512
Nitrogen	73.75	0.000	trans-2-Butene	4.37	1.154
Hydrogen Sulphide	9.38	1.505	cis-2-Butene	3.11	0.822
Carbon Dioxide	0.00	0.000	i-Pentane	12.46	4.232
Methane	6.36	0.480	n-Pentane	0.95	0.323
Ethane	3.71	0.525	1-Pentene	0.22	0.073
Ethylene	3.72	0.491	2-Methyl-1-Butene	0.34	0.112
Propane	5.75	1.194	trans-2-Pentene	0.49	0.162
Propene	16.06	3.182	cis-2-Pentene	0.86	0.284
i-Butane	16.42	4.493	2-Methyl-2-Butene	0.78	0.258
n-Butane	4.87	1.333	C6+	5.29	2.316

Total Moles :174.18

Molar Mass : 33.95
Hydrocarbon : 50.64

RUN CONDITIONS

Room Temperature :	23.0	Catalyst Charge g:	2.1506
Atm. Press. mmHg:	756.2	Fresh Feed g:	0.9517
Gas Volume mL:	427.0	Reactor Liquid g:	0.6173
Cat. Bed Temp. :	490.0	Injection Time s:	130.0200
Carbon on Cat. :	2.20	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.1		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.020	C5 n-Paraffin :	0.210
C4 n-Paraffin :	0.010	C5 Olefin :	0.840
C4 Olefin :	0.080	IBP-216 EP :	69.000
C5 i-Paraffin :	1.650	IBP-343 EP :	91.600

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD25

Date of Run 87-05-20
Catalyst Type DA 440
Fresh Feed LLOYD-DB3
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen :	0.02	0.00	0.000	0.000
Hydrogen Sulphide :	1.50	0.00	0.019	0.000
Methane :	0.48	0.00	0.006	0.000
Ethane :	0.53	0.00	0.007	0.000
Ethylene :	0.49	0.00	0.006	0.000
Propane :	1.19	2.35	0.015	0.030
Propylene :	3.18	6.10	0.040	0.077
i-Butane :	4.51	8.00	0.056	0.101
n-Butane :	1.34	2.29	0.017	0.029
C4 Olefins :	3.31	5.43	0.041	0.069
i-Pentane :	5.30	8.49	0.066	0.108
n-Pentane :	0.46	0.73	0.006	0.009
C5 Olefins :	1.43	2.18	0.018	0.028
C6+ Gasoline (216C EP):	45.25	58.01	0.566	0.735
LCO (216C-343C Cut):	14.66	15.76	0.183	0.200
Decant (343C+ Cut):	5.45	5.29	0.068	0.067
Coke Make :	10.90		0.136	
REL & REG OVERALL YIELDS				
Effluent Liquid :	64.86			
Effluent Gas (meas.) :	24.42			
Effluent Gas (calc.) :	0.00			
Conversion :	79.89	78.95		

Catalyst Charge g : 2.151
Fresh Feed g : 0.952
Catalyst to Oil : 2.260
Coke on Catalyst : 2.420

Liquid SV, W/(W.hr) : 12.3
Gas SV, V/(V.sec) : 0.77

MASS BALANCE (mass% FF) : 94.75 Analytical
94.57 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD26

Date of Run 87-05-21
Catalyst Type DA 440
Fresh Feed ATH-DB3
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.54	0.018	1-Butene	2.78	0.635
Carbon Monoxide	0.37	0.042	2-Methylpropene	1.85	0.423
Nitrogen	74.86	0.000	trans-2-Butene	4.00	0.914
Hydrogen Sulphide	11.19	1.553	cis-2-Butene	2.82	0.644
Carbon Dioxide	0.00	0.000	i-Pentane	11.89	3.494
Methane	6.56	0.429	n-Pentane	0.96	0.282
Ethane	3.88	0.475	1-Pentene	0.21	0.060
Ethylene	3.91	0.447	2-Methyl-1-Butene	0.37	0.106
Propane	5.77	1.036	trans-2-Pentene	0.61	0.174
Propene	15.88	2.722	cis-2-Pentene	0.75	0.214
i-Butane	16.07	3.804	2-Methyl-2-Butene	0.84	0.240
n-Butane	4.26	1.008	C6+	5.03	1.905

Total Moles :175.40

Molar Mass : 33.43
Hydrocarbon : 49.63

RUN CONDITIONS

Room Temperature :	23.0	Catalyst Charge g:	2.1254
Atm. Press. mmHg:	756.6	Fresh Feed g:	0.9384
Gas Volume mL:	386.0	Reactor Liquid g:	0.5812
Cat. Bed Temp. :	490.0	Injection Time s:	130.0200
Carbon on Cat. :	2.27	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.4		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.010	C5 n-Paraffin :	0.220
C4 n-Paraffin :	0.010	C5 Olefin :	0.860
C4 Olefin :	0.080	IBP-216 EP :	65.000
C5 i-Paraffin :	1.570	IBP-343 EP :	90.800

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD26

Date of Run 87-05-21
Catalyst Type DA 440
Fresh Feed ATH-DB3
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	YIELD Mass %	YIELD Vol. %	YIELD/CONVERSION m/m	YIELD/CONVERSION V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.55	0.00	0.020	0.000
Methane	0.43	0.00	0.005	0.000
Ethane	0.48	0.00	0.006	0.000
Ethylene	0.45	0.00	0.006	0.000
Propane	1.04	2.04	0.013	0.026
Propylene	2.72	5.21	0.034	0.067
i-Butane	3.81	6.77	0.048	0.087
n-Butane	1.01	1.74	0.013	0.022
C4 Olefins	2.67	4.37	0.034	0.056
i-Pentane	4.47	7.15	0.057	0.092
n-Pentane	0.42	0.66	0.005	0.009
C5 Olefins	1.33	2.02	0.017	0.026
C6+ Gasoline (216C EP)	41.08	52.67	0.520	0.676
LCO (216C-343C Cut)	15.36	16.52	0.195	0.212
Decant (343C+ Cut)	5.70	5.53	0.072	0.071
Coke Make	17.48		0.221	
REL & REG OVERALL YIELDS				
Effluent Liquid	61.94			
Effluent Gas (meas.)	20.95			
Effluent Gas (calc.)	0.00			
Conversion	78.94	77.95		

Catalyst Charge g : 2.125
Fresh Feed g : 0.938
Catalyst to Oil : 2.265
Coke on Catalyst : 2.497

Liquid SV, W/(W.hr) : 12.2
Gas SV, V/(V.sec) : 0.75

MASS BALANCE (mass% FF) : 88.54 Analytical
88.18 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD27

Date of Run 87-05-21
Catalyst Type DA 440
Fresh Feed SYN-DB4
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed
Hydrogen	0.50	0.016
Carbon Monoxide	0.00	0.000
Nitrogen	81.24	0.000
Hydrogen Sulphide	11.55	1.119
Carbon Dioxide	0.00	0.000
Methane	8.68	0.396
Ethane	3.22	0.275
Ethylene	4.27	0.341
Propane	4.62	0.579
Propene	16.38	1.960
i-Butane	13.98	2.311
n-Butane	3.03	0.501
1-Butene	3.38	0.539
2-Methylpropene	2.08	0.332
trans-2-Butene	3.96	0.632
cis-2-Butene	2.86	0.456
i-Pentane	10.92	2.241
n-Pentane	0.67	0.137
1-Pentene	0.48	0.096
2-Methyl-1-Butene	0.60	0.120
trans-2-Pentene	0.95	0.189
cis-2-Pentene	1.18	0.235
2-Methyl-2-Butene	1.55	0.309
C6+	5.64	1.492

Total Moles :181.74

Molar Mass : 31.92
Hydrocarbon : 48.86

RUN CONDITIONS

Room Temperature	23.0	Catalyst Charge g:	2.1800
Atm. Press. mmHg:	756.6	Fresh Feed g:	0.9850
Gas Volume mL:	389.0	Reactor Liquid g:	0.7254
Cat. Bed Temp.	490.0	Injection Time s:	130.0500
Carbon on Cat.	2.44	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin	0.000	C5 n-Paraffin	0.130
C4 n-Paraffin	0.000	C5 Olefin	0.500
C4 Olefin	0.000	IBP-216 EP	39.200
C5 i-Paraffin	0.500	IBP-343 EP	67.300

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD27

Date of Run 87-05-21
Catalyst Type DA 440
Fresh Feed SYN-DB4
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	YIELD Mass %	YIELD Vol. %	YIELD/CONVERSION m/m	YIELD/CONVERSION V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.12	0.00	0.020	0.000
Methane	0.40	0.00	0.007	0.000
Ethane	0.28	0.00	0.005	0.000
Ethylene	0.34	0.00	0.006	0.000
Propane	0.58	1.14	0.010	0.021
Propylene	1.96	3.76	0.035	0.069
i-Butane	2.31	4.10	0.042	0.075
n-Butane	0.50	0.86	0.009	0.016
C4 Olefins	1.96	3.21	0.035	0.059
i-Pentane	2.61	4.18	0.047	0.077
n-Pentane	0.23	0.37	0.004	0.007
C5 Olefins	1.32	2.01	0.024	0.037
C6+ Gasoline (216C EP)	29.53	37.86	0.535	0.696
LCO (216C-343C Cut)	20.69	22.25	0.375	0.409
Decant (343C+ Cut)	24.08	23.38	0.436	0.430
Coke Make	12.08		0.219	
REL & REG OVERALL YIELDS				
Effluent Liquid	73.64			
Effluent Gas (meas.)	14.83			
Effluent Gas (calc.)	0.00			
Conversion	55.22	54.37		

Catalyst Charge g : 2.180
Fresh Feed g : 0.985
Catalyst to Oil : 2.213
Coke on Catalyst : 2.684

Liquid SV, W/(W.hr) : 12.5
Gas SV, V/(V.sec) : 0.78

MASS BALANCE (mass% FF) : 94.42 Analytical
93.86 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD28

Date of Run 87-05-22
Catalyst Type DA 440
Fresh Feed LLOYD-DB4
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.70	0.023	1-Butene	2.44	0.595
Carbon Monoxide	0.34	0.041	2-Methylpropene	1.62	0.395
Nitrogen	72.43	0.000	trans-2-Butene	3.58	0.874
Hydrogen Sulphide	11.14	1.651	cis-2-Butene	2.55	0.622
Carbon Dioxide	0.00	0.000	i-Pentane	12.27	3.850
Methane	8.26	0.576	n-Pentane	0.88	0.276
Ethane	3.76	0.492	1-Pentene	0.25	0.076
Ethylene	3.79	0.462	2-Methyl-1-Butene	0.29	0.088
Propane	5.76	1.105	trans-2-Pentene	0.48	0.146
Propene	15.52	2.840	cis-2-Pentene	0.56	0.171
i-Butane	16.78	4.242	2-Methyl-2-Butene	0.74	0.226
n-Butane	3.98	1.006	C6+	5.01	2.026

Total Moles :173.13

Molar Mass : 33.75
Hydrocarbon : 48.89

RUN CONDITIONS

Room Temperature :	24.0	Catalyst Charge g:	2.1494
Atm. Press. mmHg:	753.5	Fresh Feed g:	0.9782
Gas Volume mL:	395.0	Reactor Liquid g:	0.6075
Cat. Bed Temp. :	490.0	Injection Time s:	130.1000
Carbon on Cat. :	3.26	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.2		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.030	C5 n-Paraffin :	0.220
C4 n-Paraffin :	0.020	C5 Olefin :	0.900
C4 Olefin :	0.110	IBP-216 EP :	67.500
C5 i-Paraffin :	1.950	IBP-343 EP :	91.300

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD28

Date of Run 87-05-22
Catalyst Type DA 440
Fresh Feed LLOYD-DB4
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen :	0.02	0.00	0.000	0.000
Hydrogen Sulphide :	1.65	0.00	0.021	0.000
Methane :	0.58	0.00	0.007	0.000
Ethane :	0.49	0.00	0.006	0.000
Ethylene :	0.46	0.00	0.006	0.000
Propane :	1.10	2.18	0.014	0.028
Propylene :	2.84	5.44	0.036	0.069
i-Butane :	4.26	7.57	0.053	0.096
n-Butane :	1.02	1.74	0.013	0.022
C4 Olefins :	2.56	4.19	0.032	0.053
i-Pentane :	5.06	8.10	0.063	0.103
n-Pentane :	0.41	0.65	0.005	0.008
C5 Olefins :	1.27	1.93	0.016	0.024
C6+ Gasoline (216C EP):	41.94	53.77	0.525	0.682
LCO (216C-343C Cut):	14.78	15.89	0.185	0.202
Decant (343C+ Cut):	5.40	5.25	0.068	0.067
Coke Make :	16.15		0.202	
REL & REG OVERALL YIELDS				
Effluent Liquid :	62.10			
Effluent Gas (meas.) :	22.06			
Effluent Gas (calc.) :	0.00			
Conversion :	79.82	78.86		

Catalyst Charge g : 2.149
Fresh Feed g : 0.978
Catalyst to Oil : 2.197
Coke on Catalyst : 3.586

Liquid SV, W/(W.hr) : 12.6
Gas SV, V/(V.sec) : 0.76

MASS BALANCE (mass% FF) : 92.04 Analytical
91.73 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD29

Date of Run 87-05-22
Catalyst Type DA 440
Fresh Feed ATH-DB4
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.71	0.025	1-Butene	2.60	0.617
Carbon Monoxide	0.50	0.059	2-Methylpropene	1.73	0.410
Nitrogen	74.68	0.000	trans-2-Butene	3.66	0.868
Hydrogen Sulphide	11.56	1.665	cis-2-Butene	2.63	0.624
Carbon Dioxide	0.00	0.000	i-Pentane	12.17	3.712
Methane	8.30	0.563	n-Pentane	0.90	0.274
Ethane	3.59	0.456	1-Pentene	0.28	0.083
Ethylene	3.76	0.446	2-Methyl-1-Butene	0.36	0.107
Propane	5.33	0.994	trans-2-Pentene	0.56	0.166
Propene	15.42	2.743	cis-2-Pentene	0.91	0.270
i-Butane	15.94	3.916	2-Methyl-2-Butene	0.91	0.270
n-Butane	3.68	0.904	C6+	5.21	2.048

Total Moles :175.39

Molar Mass : 33.27
Hydrocarbon : 48.89

RUN CONDITIONS

Room Temperature :	24.5	Catalyst Charge g:	2.1649
Atm. Press. mmHg:	753.1	Fresh Feed g:	0.9960
Gas Volume mL:	425.0	Reactor Liquid g:	0.6090
Cat. Bed Temp. :	490.0	Injection Time s:	130.0200
Carbon on Cat. :	3.60	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.020	C5 n-Paraffin :	0.210
C4 n-Paraffin :	0.010	C5 Olefin :	0.860
C4 Olefin :	0.060	IBP-216 EP :	65.500
C5 i-Paraffin :	1.510	IBP-343 EP :	90.600

05-29-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD29

Date of Run 87-05-22
Catalyst Type DA 440
Fresh Feed ATH-DB4
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.67	0.00	0.021	0.000
Methane	0.56	0.00	0.007	0.000
Ethane	0.46	0.00	0.006	0.000
Ethylene	0.45	0.00	0.006	0.000
Propane	0.99	1.96	0.013	0.025
Propylene	2.74	5.25	0.035	0.067
i-Butane	3.93	6.98	0.050	0.090
n-Butane	0.91	1.56	0.012	0.020
C4 Olefins	2.56	4.19	0.032	0.054
i-Pentane	4.64	7.42	0.059	0.095
n-Pentane	0.40	0.64	0.005	0.008
C5 Olefins	1.42	2.16	0.018	0.028
C6+ Gasoline (216C EP)	40.47	51.88	0.513	0.666
LCO (216C-343C Cut)	15.35	16.50	0.195	0.212
Decant (343C+ Cut)	5.75	5.58	0.073	0.072
Coke Make	17.69		0.224	
REL & REG OVERALL YIELDS				
Effluent Liquid	61.14			
Effluent Gas (meas.)	21.33			
Effluent Gas (calc.)	0.00			
Conversion	78.91	77.92		

Catalyst Charge g : 2.165
Fresh Feed g : 0.996
Catalyst to Oil : 2.174
Coke on Catalyst : 3.960

Liquid SV, W/(W.hr) : 12.7
Gas SV, V/(V.sec) : 0.79

MASS BALANCE (mass% FF) : 91.08 Analytical
90.91 Flow

05-29-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD30

Date of Run 87-05-25
Catalyst Type DA 440
Fresh Feed SYN-DB5
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.87	0.028	1-Butene	3.49	0.588
Carbon Monoxide	1.01	0.085	2-Methylpropene	2.33	0.393
Nitrogen	80.10	0.000	trans-2-Butene	4.12	0.694
Hydrogen Sulphide	11.94	1.222	cis-2-Butene	2.89	0.487
Carbon Dioxide	0.00	0.000	i-Pentane	10.47	2.268
Methane	5.34	0.257	n-Pentane	0.77	0.167
Ethane	3.54	0.320	1-Pentene	0.55	0.116
Ethylene	4.62	0.389	2-Methyl-1-Butene	0.62	0.131
Propane	4.76	0.630	trans-2-Pentene	1.03	0.217
Propene	17.16	2.168	cis-2-Pentene	1.31	0.276
i-Butane	14.50	2.530	2-Methyl-2-Butene	1.28	0.270
n-Butane	3.05	0.532	C6+	5.22	1.456

Total Moles :180.97

Molar Mass : 32.09
Hydrocarbon : 48.69

RUN CONDITIONS

Room Temperature :	23.0	Catalyst Charge g:	2.1758
Atm. Press. mmHg:	758.4	Fresh Feed g:	0.9442
Gas Volume mL:	361.0	Reactor Liquid g:	0.7561
Cat. Bed Temp. :	490.0	Injection Time s:	130.1300
Carbon on Cat. :	1.45	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.010	C5 n-Paraffin :	0.160
C4 n-Paraffin :	0.010	C5 Olefin :	0.650
C4 Olefin :	0.010	IBP-216 EP :	42.200
C5 i-Paraffin :	0.680	IBP-343 EP :	71.700

06-01-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD30

Date of Run 87-05-25
Catalyst Type DA 440
Fresh Feed SYN-DB5
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	YIELD Mass %	YIELD Vol. %	YIELD/CONVERSION m/m	YIELD/CONVERSION V/V
Hydrogen	0.03	0.00	0.001	0.000
Hydrogen Sulphide	1.22	0.00	0.023	0.000
Methane	0.26	0.00	0.005	0.000
Ethane	0.32	0.00	0.006	0.000
Ethylene	0.39	0.00	0.007	0.000
Propane	0.63	1.24	0.012	0.024
Propylene	2.17	4.15	0.040	0.079
i-Butane	2.54	4.51	0.047	0.086
n-Butane	0.54	0.92	0.010	0.018
C4 Olefins	2.17	3.56	0.040	0.068
i-Pentane	2.81	4.50	0.052	0.086
n-Pentane	0.29	0.47	0.005	0.009
C5 Olefins	1.53	2.33	0.028	0.044
C6+ Gasoline (216C EP)	34.03	43.63	0.634	0.830
LCO (216C-343C Cut)	23.62	25.40	0.440	0.483
Decant (343C+ Cut)	22.66	22.00	0.422	0.418
Coke Make	4.78		0.089	
REL & REG OVERALL YIELDS				
Effluent Liquid	80.08			
Effluent Gas (meas.)	15.06			
Effluent Gas (calc.)	0.00			
Conversion	53.71	52.60		

Catalyst Charge g : 2.176
Fresh Feed g : 0.944
Catalyst to Oil : 2.304
Coke on Catalyst : 1.595

Liquid SV, W/(W.hr) : 12.0
Gas SV, V/(V.sec) : 0.73

MASS BALANCE (mass% FF) : 98.82 Analytical
98.89 Flow

06-01-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD31

Date of Run 87-05-25
Catalyst Type DA 440
Fresh Feed ATH-DB5
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.87	0.033	1-Butene	2.54	0.656
Carbon Monoxide	0.72	0.093	2-Methylpropene	1.69	0.437
Nitrogen	74.87	0.000	trans-2-Butene	3.70	0.956
Hydrogen Sulphide	11.71	1.838	cis-2-Butene	2.68	0.693
Carbon Dioxide	0.00	0.000	i-Pentane	12.29	4.084
Methane	6.45	0.477	n-Pentane	0.91	0.302
Ethane	3.91	0.542	1-Pentene	0.22	0.071
Ethylene	4.06	0.525	2-Methyl-1-Butene	0.35	0.113
Propane	5.52	1.121	trans-2-Pentene	0.53	0.171
Propene	15.72	3.047	cis-2-Pentene	0.89	0.288
i-Butane	16.26	4.353	2-Methyl-2-Butene	0.89	0.288
n-Butane	3.82	1.023	C6+	5.14	2.202

Total Moles :175.74

Molar Mass : 33.25
Hydrocarbon : 49.00

RUN CONDITIONS

Room Temperature :	23.0	Catalyst Charge g:	2.1565
Atm. Press. mmHg:	758.5	Fresh Feed g:	0.9253
Gas Volume mL:	427.0	Reactor Liquid g:	0.6072
Cat. Bed Temp. :	490.0	Injection Time s:	130.0300
Carbon on Cat. :	2.82	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.4		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.020	C5 n-Paraffin :	0.210
C4 n-Paraffin :	0.010	C5 Olefin :	0.820
C4 Olefin :	0.060	IBP-216 EP :	65.800
C5 i-Paraffin :	1.590	IBP-343 EP :	91.100

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD31

Date of Run 87-05-25
Catalyst Type DA 440
Fresh Feed ATH-DB5
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen :	0.03	0.00	0.000	0.000
Hydrogen Sulphide :	1.84	0.00	0.024	0.000
Methane :	0.48	0.00	0.006	0.000
Ethane :	0.54	0.00	0.007	0.000
Ethylene :	0.52	0.00	0.007	0.000
Propane :	1.12	2.21	0.014	0.029
Propylene :	3.05	5.84	0.039	0.076
i-Butane :	4.37	7.75	0.056	0.101
n-Butane :	1.03	1.76	0.013	0.023
C4 Olefins :	2.78	4.56	0.036	0.060
i-Pentane :	5.13	8.21	0.066	0.107
n-Pentane :	0.44	0.70	0.006	0.009
C5 Olefins :	1.47	2.24	0.019	0.029
C6+ Gasoline (216C EP):	43.60	55.90	0.562	0.731
LCO (216C-343C Cut):	16.60	17.85	0.214	0.233
Decant (343C+ Cut):	5.84	5.67	0.075	0.074
Coke Make :	11.16		0.144	
REL & REG OVERALL YIELDS				
Effluent Liquid :	65.62			
Effluent Gas (meas.) :	23.18			
Effluent Gas (calc.) :	0.00			
Conversion :	77.56	76.48		

Catalyst Charge g : 2.157
Fresh Feed g : 0.925
Catalyst to Oil : 2.331
Coke on Catalyst : 3.102

Liquid SV, W/(W.hr) : 11.9
Gas SV, V/(V.sec) : 0.76

MASS BALANCE (mass% FF) : 96.03 Analytical
96.07 Flow

06-01-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD34

Date of Run 87-05-27
Catalyst Type DA 440
Fresh Feed LLOYD-DB5
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.85	0.028	1-Butene	2.91	0.688
Carbon Monoxide	0.86	0.101	2-Methylpropene	1.94	0.45[illegible]
Nitrogen	73.27	0.000	trans-2-Butene	3.87	0.915
Hydrogen Sulphide	11.26	1.617	cis-2-Butene	2.78	0.657
Carbon Dioxide	0.30	0.056	i-Pentane	11.50	3.49[illegible]
Methane	7.16	0.484	n-Pentane	0.76	0.231
Ethane	4.11	0.521	1-Pentene	0.28	0.083
Ethylene	3.86	0.456	2-Methyl-1-Butene	0.26	0.077
Propane	5.28	0.981	trans-2-Pentene	0.56	0.165
Propene	16.27	2.885	cis-2-Pentene	0.65	0.19[illegible]
i-Butane	16.02	3.923	2-Methyl-2-Butene	0.86	0.25[illegible]
n-Butane	3.61	0.884	C6+	4.90	1.92[illegible]

Total Moles :174.12

Molar Mass : 33.47
Hydrocarbon : 48.61

RUN CONDITIONS

Room Temperature :	25.0	Catalyst Charge g:	2.1632
Atm. Press. mmHg:	756.0	Fresh Feed g:	0.9851
Gas Volume mL:	393.0	Reactor Liquid g:	0.6682
Cat. Bed Temp. :	490.0	Injection Time s:	130.0000
Carbon on Cat. :	3.46	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.030	C5 n-Paraffin :	0.250
C4 n-Paraffin :	0.020	C5 Olefin :	1.000
C4 Olefin :	0.110	IBP-216 EP :	64.800
C5 i-Paraffin :	1.710	IBP-343 EP :	90.400

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD34

Date of Run 87-05-27
Catalyst Type DA 440
Fresh Feed LLOYD-DB5
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.03	0.00	0.000	0.000
Hydrogen Sulphide	1.62	0.00	0.021	0.000
Methane	0.48	0.00	0.006	0.000
Ethane	0.52	0.00	0.007	0.000
Ethylene	0.46	0.00	0.006	0.000
Propane	0.98	1.93	0.013	0.026
Propylene	2.88	5.53	0.038	0.074
i-Butane	3.94	7.00	0.052	0.093
n-Butane	0.90	1.54	0.012	0.020
C4 Olefins	2.79	4.58	0.037	0.061
i-Pentane	4.66	7.45	0.061	0.099
n-Pentane	0.40	0.63	0.005	0.008
C5 Olefins	1.45	2.21	0.019	0.029
C6+ Gasoline (216C EP)	43.76	56.10	0.575	0.748
LCO (216C-343C Cut)	17.36	18.67	0.228	0.249
Decant (343C+ Cut)	6.51	6.32	0.086	0.084
Coke Make	11.25		0.148	
REL & REG OVERALL YIELDS				
Effluent Liquid	67.83			
Effluent Gas (meas.)	20.84			
Effluent Gas (calc.)	0.00			
Conversion	76.12	75.01		

Catalyst Charge g : 2.163
Fresh Feed g : 0.985
Catalyst to Oil : 2.196
Coke on Catalyst : 3.806

Liquid SV, W/(W.hr) : 12.6
Gas SV, V/(V.sec) : 0.75

MASS BALANCE (mass% FF) : 97.03 Analytical
97.10 Flow

06-01-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD35

Date of Run 87-05-27
Catalyst Type DA 440
Fresh Feed SYN-DB6
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.65	0.020	1-Butene	3.54	0.606
Carbon Monoxide	0.58	0.050	2-Methylpropene	2.12	0.363
Nitrogen	79.38	0.000	trans-2-Butene	4.08	0.698
Hydrogen Sulphide	16.93	1.759	cis-2-Butene	2.94	0.503
Carbon Dioxide	0.15	0.020	i-Pentane	9.71	2.136
Methane	5.83	0.285	n-Pentane	0.79	0.174
Ethane	3.58	0.328	1-Pentene	0.46	0.098
Ethylene	4.21	0.360	2-Methyl-1-Butene	0.48	0.103
Propane	3.91	0.526	trans-2-Pentene	1.03	0.220
Propene	16.51	2.119	cis-2-Pentene	1.18	0.252
i-Butane	13.02	2.308	2-Methyl-2-Butene	1.46	0.312
n Butane	2.43	0.431	C6+	5.06	1.435

Total Moles :180.03

Molar Mass : 32.13
Hydrocarbon : 48.09

RUN CONDITIONS

Room Temperature :	23.5	Catalyst Charge g:	2.1432
Atm. Press. mmHg:	756.2	Fresh Feed g:	1.0623
Gas Volume mL:	400.0	Reactor Liquid g:	0.8289
Cat. Bed Temp. :	490.0	Injection Time s:	130.0200
Carbon on Cat. :	3.20	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.000	C5 n-Paraffin :	0.170
C4 n-Paraffin :	0.000	C5 Olefin :	0.680
C4 Olefin :	0.000	IBP-216 EP :	42.800
C5 i-Paraffin :	0.670	IBP-343 EP :	72.200

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD35

Date of Run 87-05-27
Catalyst Type DA 440
Fresh Feed SYN-D86
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	YIELD Mass %	YIELD Vol. %	YIELD/CONVERSION m/m	YIELD/CONVERSION V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.76	0.00	0.032	0.000
Methane	0.29	0.00	0.005	0.000
Ethane	0.33	0.00	0.006	0.000
Ethylene	0.36	0.00	0.007	0.000
Propane	0.53	1.04	0.009	0.019
Propylene	2.12	4.06	0.038	0.075
i-Butane	2.31	4.10	0.042	0.076
n-Butane	0.43	0.74	0.008	0.014
C4 Olefins	2.17	3.56	0.039	0.066
i-Pentane	2.66	4.26	0.048	0.078
n-Pentane	0.31	0.49	0.006	0.009
C5 Olefins	1.52	2.31	0.027	0.043
C6+ Gasoline (216C EP)	33.65	43.13	0.608	0.795
LCO (216C-343C Cut)	22.94	24.67	0.414	0.455
Decant (343C+ Cut)	21.69	21.06	0.392	0.388
Coke Make	6.94		0.125	
REL & REG OVERALL YIELDS				
Effluent Liquid	78.03			
Effluent Gas (meas.)	15.16			
Effluent Gas (calc.)	0.00			
Conversion	55.37	54.27		

Catalyst Charge g : 2.143
Fresh Feed g : 1.062
Catalyst to Oil : 2.018
Coke on Catalyst : 3.520

Liquid SV, W/(W.hr) : 13.7
Gas SV, V/(V.sec) : 0.83

MASS BALANCE (mass% FF) : 100.29 Analytical
100.17 Flow

06-01-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD36

Date of Run 87-05-28
Catalyst Type DA 440
Fresh Feed SYN-D87
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.67	0.022	1-Butene	4.08	0.817
Carbon Monoxide	0.00	0.000	2-Methylpropene	2.72	0.544
Nitrogen	76.98	0.000	trans-2-Butene	5.74	1.149
Hydrogen Sulphide	11.00	1.337	cis-2-Butene	4.10	0.821
Carbon Dioxide	0.00	0.000	i-Pentane	10.15	2.612
Methane	4.00	0.229	n-Pentane	0.78	0.201
Ethane	2.98	0.320	1-Pentene	0.37	0.093
Ethylene	4.33	0.433	2-Methyl-1-Butene	0.42	0.105
Propane	4.24	0.667	trans-2-Pentene	0.89	0.223
Propene	17.25	2.589	cis-2-Pentene	0.95	0.238
i-Butane	15.76	3.267	2-Methyl-2-Butene	1.20	0.300
n-Butane	4.24	0.879	C6+	4.80	1.592

Total Moles :177.65

Molar Mass : 33.11
Hydrocarbon : 50.18

RUN CONDITIONS

Room Temperature	25.0	Catalyst Charge g:	2.1345
Atm. Press. mmHg:	756.8	Fresh Feed g:	0.9334
Gas Volume mL:	373.0	Reactor Liquid g:	0.7259
Cat. Bed Temp. :	490.0	Injection Time s:	130.1000
Carbon on Cat. :	1.23	Feed Density g/mL:	1.0000
N2 Flow ml/min:	19.3		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin	0.000	C5 n-Paraffin	0.190
C4 n-Paraffin	0.030	C5 Olefin	0.770
C4 Olefin	0.080	IBP-216 EP	51.200
C5 i-Paraffin	1.020	IBP-343 EP	82.200

06-01-1987

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD36

Date of Run 87-05-28
Catalyst Type DA 440
Fresh Feed SYN-DB7
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.02	0.00	0.000	0.000
Hydrogen Sulphide	1.34	0.00	0.022	0.000
Methane	0.23	0.00	0.004	0.000
Ethane	0.32	0.00	0.005	0.000
Ethylene	0.43	0.00	0.007	0.000
Propane	0.67	1.31	0.011	0.022
Propylene	2.59	4.96	0.042	0.082
i-Butane	3.27	5.80	0.053	0.096
n-Butane	0.90	1.54	0.015	0.025
C4 Olefins	3.39	5.56	0.055	0.092
i-Pentane	3.41	5.45	0.055	0.090
n-Pentane	0.35	0.55	0.006	0.009
C5 Olefins	1.56	2.37	0.025	0.039
C6+ Gasoline (216C EP)	39.78	51.01	0.641	0.841
LCO (216C-343C Cut)	24.11	25.92	0.389	0.428
Decant (343C+ Cut)	13.84	13.44	0.223	0.222
Coke Make	3.79		0.061	
REL & REG OVERALL YIELDS				
Effluent Liquid	77.77			
Effluent Gas (meas.)	18.79			
Effluent Gas (calc.)	0.00			
Conversion	62.05	60.64		

Catalyst Charge g : 2.135
Fresh Feed g : 0.933
Catalyst to Oil : 2.287
Coke on Catalyst : 1.353

Liquid SV, W/(W.hr) : 12.1
Gas SV, V/(V.sec) : 0.74

MASS BALANCE (mass% FF) : 99.65 Analytical
99.30 Flow

06-01-1987

MICROACTIVITY TEST: INPUT PARAMETERS

FILE NAME : MATD37

Date of Run 87-05-28
Catalyst Type DA 440
Fresh Feed ATH-D87
Comments

GAS CHROMATOGRAPHIC ANALYSIS
REACTOR EFFLUENT GAS

Compound	Moles	% Feed	Compound	Moles	% Feed
Hydrogen	0.74	0.029	1-Butene	2.76	0.737
Carbon Monoxide	0.00	0.000	2-Methylpropene	1.84	0.491
Nitrogen	74.45	0.000	trans-2-Butene	4.21	1.124
Hydrogen Sulphide	11.03	1.789	cis-2-Butene	3.00	0.801
Carbon Dioxide	0.00	0.000	i-Pentane	11.99	4.117
Methane	5.91	0.451	n-Pentane	0.89	0.306
Ethane	3.56	0.509	1-Pentene	0.22	0.073
Ethylene	3.88	0.518	2-Methyl-1-Butene	0.29	0.097
Propane	5.32	1.116	trans-2-Pentene	0.60	0.200
Propene	15.15	3.034	cis-2-Pentene	0.66	0.220
i-Butane	16.50	4.564	2-Methyl-2-Butene	0.81	0.270
n-Butane	6.27	1.734	C6+	5.10	2.257

Total Moles :175.18

Molar Mass : 33.60
Hydrocarbon : 49.87

RUN CONDITIONS

Room Temperature :	25.0	Catalyst Charge g:	2.2380
Atm. Press. mmHg:	756.0	Fresh Feed g:	0.9044
Gas Volume mL:	430.0	Reactor Liquid g:	0.5778
Cat. Bed Temp. :	490.0	Injection Time s:	130.0200
Carbon on Cat. :	3.21	Feed Density g/mL:	1.0000
N2 Flow ml/min:	21.4		

REACTOR EFFLUENT LIQUID

C4 i-Paraffin :	0.000	C5 n-Paraffin :	0.150
C4 n-Paraffin :	0.000	C5 Olefin :	0.620
C4 Olefin :	0.000	IBP-216 EP :	66.000
C5 i-Paraffin :	1.180	IBP-343 EP :	91.300

MICROACTIVITY TEST: PRODUCT YIELD STRUCTURE

FILE NAME : MATD37

Date of Run 87-05-28
Catalyst Type DA 440
Fresh Feed ATH-DB7
Comments

PRODUCT YIELD STRUCTURE
(% Fresh Feed)

	---- YIELD ---- Mass %	Vol. %	YIELD/CONVERSION m/m	V/V
Hydrogen	0.03	0.00	0.000	0.000
Hydrogen Sulphide	1.79	0.00	0.023	0.000
Methane	0.45	0.00	0.006	0.000
Ethane	0.51	0.00	0.007	0.000
Ethylene	0.52	0.00	0.007	0.000
Propane	1.12	2.20	0.014	0.028
Propylene	3.03	5.81	0.039	0.075
i-Butane	4.56	8.10	0.058	0.105
n-Butane	1.73	2.97	0.022	0.038
C4 Olefins	3.15	5.17	0.040	0.067
i-Pentane	4.87	7.80	0.062	0.101
n-Pentane	0.40	0.64	0.005	0.008
C5 Olefins	1.26	1.91	0.016	0.025
C6+ Gasoline (216C EP)	43.18	55.36	0.552	0.717
LCO (216C-343C Cut)	16.16	17.38	0.206	0.225
Decant (343C+ Cut)	5.56	5.40	0.071	0.070
Coke Make	11.67		0.149	
REL & REG OVERALL YIELDS				
Effluent Liquid	63.89			
Effluent Gas (meas.)	24.63			
Effluent Gas (calc.)	0.00			
Conversion	78.28	77.22		

Catalyst Charge g : 2.238
Fresh Feed g : 0.904
Catalyst to Oil : 2.475
Coke on Catalyst : 3.531

Liquid SV, W/(W.hr) : 11.2
Gas SV, V/(V.sec) : 0.72

MASS BALANCE (mass% FF) : 97.26 Analytical
97.06 Flow

06-01-1987